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With International Abstract of Surgery

VOLUME 77 July, 1943 NUMBER 1

The Newer Concepts of Meat in Nutrition

Meat . . .

The Demands of War, and The Protein Needs of the Patient

WHILE the demands of war perforce had to curtail civilian meat supplies, the needs of the ill have not been overlooked in rationing regulations. The prerogative of the physician—to specify the requirements of his patient—is given the recognition it deserves.

Though hospital allotments were originally held to 80% of supplies used during December 1942, every hospital was given the right to ask for additional supplies, not only because December is one of the low hospital months of the year, but also because changes in hospitalization needs obviously cannot be predicted.

For the nonhospitalized patient under the physician's continuing care, the physician's delineation of the patient's requirements usually is recognized by rationing boards.

In the many instances when the dietary calls for a greater meat allowance because of increased protein needs, as in

PROLONGED INFECTIOUS DISEASE . .

AFTER SURGERY AND EXTENSIVE TRAUMA . .

THE ANEMIAS . .

ENTERIC DISEASE . .

MYXEDEMA . .

NEPHROSIS . .

CERTAIN URINARY INFECTIONS, ETC.,

it remains as always the physician's responsibility and privilege to specify the required amount.

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PERINEAL PROSTATECTOMY VERSUS TRANSURETHRAL RESECTION FOR HYPERTROPHY AND CANCER OF THE PROSTATE

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AS the author of the original instrument for urethroscopic transurethral prostatic resection which now, in one form or another, has been used in thousands of cases, I hesitate to take a stand against the widespread use of this procedure in all types of hypertrophy of the prostate, but I deem it high time to bring forth certain facts and experiences which I believe should be more generally known.

Soon after the presentation of my "urethroscopic prostatic excisor," and the revelation that certain cases of prostatic obstruction, by its use, could be quickly relieved of chronic urinary obstruction in 1909 (4) I was tempted to extend its use from small bars and contractures at the vesical neck to greater and greater enlargements of the prostate. In these cases the frequent occurrence of troublesome hemorrhage deterred me until in 1911 I had constructed in Berlin an electrocautery punch instrument with which the prostatic masses could be removed by an electrically heated loop. Later I employed fulguration to stop actively bleeding vessels. But even with this more effective instrument the results did not satisfy me in cases of pronounced prostatic enlargement. I was forced to admit that a clean, thorough, quick enucleation of prostatic lobes through the perineum gave better results, and that the open operation was equally free from danger and far more permanent in its results.

John R. Caulk, who had worked with me during the development of these transurethral instruments, brought out his cautery punch instrument in 1921. This was a distinct improvement upon mine and could more effectively remove large prostatic masses transurethrally. Caulk soon became a great enthusiast for his transurethral instrument and proclaimed it to the world as the ideal procedure for prostatic hypertrophies, large and small. He followed his first announcement by other papers, and his reports greatly impressed the surgical world.

In the meantime, the modification of my instrument by William F. Braasch was materially improved by Bumpus, whose cases of prostatic hypertrophy in which he used my cold cutting knife added to the widespread interest in the transurethral attack upon the prostate.

Contemporaneous with the urologists mentioned came Stern (1926) with his fenestrated instrument, similar to my punch instrument,

From the James Buchanan Brady Urological Institute, Johns Hopkins Hospital.

but provided with an electric loop and a cystoscopic observation sheath, to which he gave the name of resectoscope. The instrument was improved in 1928 by Theodore Davis, who finally reported a long series of cases. Then, in 1932, Joseph McCarthy brought out his instrument, a modification of Stern's, in that he left off my fenestra. This has been the resectoscope employed most widely. In 1933 Gershom Thompson added to the Braasch-Bumpus modification of my cold cutting fenestrated punch instrument an extra tube for a fulgurating wire to stop hemorrhage. Since then Thompson has made repeated publications of hundreds of cases, demonstrating the simplicity and efficacy of the cold "punch" and the remarkably low mortality following its use. Thompson became so enthusiastic over his results that soon he was proclaiming that by means of this instrument a really complete prostatectomy could be carried out transurethrally, so much so that he dropped the title of resection and called the procedure transurethral prostatectomy.

Thousands of prostatics now have been subjected to transurethral operations and their cases reported in medical journals. In many of these articles it has been stoutly asserted by some resectionists that the ideal operation for the treatment of prostatic obstruction, large and small, benign and malignant, has been found and that, for freedom from complications and splendid ultimate results, all open operations are definitely inferior and outmoded. Others frankly have acknowledged many shortcomings and failures of transurethral prostatic resection, admitting a mortality of 3 to 4 per cent and, in the larger prostates, an even higher death rate (1, 3, 5, 7).

As the years have passed, my feeling of paternal pride in the widespread use of transurethral resection has given way to a realization that the enthusiasm displayed for this type of surgery upon the obstructive prostate has gone too far; that the transurethral operation is not entirely free from danger; that the postoperative period is not so brief as is often asserted; that more or less prolonged convalescence is necessary before the deep masses of burned tissue or eschar come away, and healing of the extensive intraprostatic wound occurs; that incontinence, which has been held up as the *bête noire* of the perineal operation, actually occurs more frequently after transurethral resection; and finally, that recurrence of obstruction or painful infections of the remaining prostatic tissue and even calculous incrustations often bring patients seeking relief after 1, 2, and even 3 transurethral resections.

Having bided my time, the moment seems opportune to assemble simple facts about the various methods of attacking prostatic obstruction and to weigh the different procedures in the balance and compare them. I have analyzed the case histories of all patients (now totaling 200 cases) who have come to the Brady Urological Institute complaining of imperfect results following transurethral resection elsewhere. Some of these were operated upon by resectionists of no great experience; but others came from the largest clinics in the country, the resections having been done by operators of wide experience in the use of various instruments; which included the cold cutting punch instruments of Young, Braasch-Bumpus, and Thompson, the cautery punch instrument of Caulk, and the electrified loop resector of Stern and McCarthy.

The multiplicity of problems presented by these patients can best be described by dividing the cases into various groups: (1) benign hypertrophy in which prostatic lobes weighing from 50 to 100 grams were enucleated by perineal prostatectomy; (2) benign hypertrophy in which prostatic lobes weighing from 100 to 200 grams were enucleated; (3) benign hypertrophy in which prostatic lobes weighing over 200 grams were enucleated; (4) benign hypertrophy in which less than 50 grams were enucleated; (5) imperfect results after resection, but prostatectomy not indicated; (6) cancer of the prostate too advanced for radical operation; (7) cancer of the prostate in which radical operation seemed to offer a possibility of cure.

1. *One or more transurethral resections elsewhere; hypertrophied lobes weighing between 50 and 100 grams enucleated.* In order to present the varied symptoms of which these patients

Fig. 1. Path. No. 9973. Lobes enucleated perineally, with relief of frequency and pain following transurethral resection which had been performed 3½ years previously. Weight, 55 grams.

Fig. 2. Path. No. 10,011. Lobes enucleated perineally, with relief of hematuria and complete retention of urine following transurethral resection 3 years before. Weight 60 grams.

complained, it seems desirable to cite a brief abstract of illustrative cases.

In the following case hypertrophied lobes weighing 55 grams were enucleated (Fig. 1).

CASE 1. (B.U.I. 25260.) C. E. F., aged 70 years, underwent a transurethral resection elsewhere 3½ years previously. Following the operation he had marked frequency and severe burning on urination, and when I saw him he was voiding 7 times at night, and the urine often was tinged with blood. Examination showed a moderately enlarged prostate, 40 cubic centimeters residual urine, no enlargement of the median but marked intraurethral lateral lobes. Urine cultures showed Staphylococcus aureus. Through the perineum I enucleated 2 large lateral lobes and a small subtrigonal lobe weighing in all 55 grams. Pathological report: Benign hypertrophy. Convalescence was slow; the wound healed in 4 weeks and the patient was discharged well. His physician reported 2½ years later that he was well.

In the next case hypertrophied lobes weighing 57 grams were enucleated, along with calculi weighing 10 grams.

CASE 2. (B.U.I. 20213.) C. B. M., aged 70 years, underwent a transurethral resection elsewhere 2 years previously, and following operation he suffered from severe infection of the bladder, dysuria, and hematuria. On examination here he had 42 cubic centimeters residual urine. Hypertrophied lobes weighing 57 grams were enucleated perineally along with calculi which weighed 10 grams. Pathological report: Benign hypertrophy and severe prostatitis. The immediate result was excellent. The patient was discharged on the 19th day. The wound had healed and he was voiding normally. His physician reported 2½ years later that the patient was well.

In the next case hypertrophied lobes weighing 60 grams were enucleated (Fig. 2).

CASE 3. (B. U. I. 25408.) P. B., aged 75 years, underwent transurethral resection elsewhere 3 years previously. On admission here he complained of occasional attacks of retention and intermittent hematuria. The prostate was considerably enlarged. The median lobe had been removed but rounded laterals were left behind at the transurethral resection. The residual urine was 25 cubic centimeters. Cultures of the urine showed proteus. A perineal prostatectomy was done by Dr. Colston and prostatic lobes weighing 60 grams were removed. Pathological report: Benign hypertrophy and chronic prostatitis. Urethral catheter drainage was employed. Convalescence was smooth until the 12th postoperative day, when feces suddenly escaped through the perineal incision. The patient left the hospital in 5 weeks. He was voiding freely, with good urinary control.

In the next case the patient complained chiefly of incontinence. Hypertrophied lobes weighing 60 grams were enucleated.

CASE 4. (B.U.I. 26051.) M. J. B., aged 74 years, continued to have marked hesitation, frequency and burning, as well as dribbling, for 4 years following transurethral resection elsewhere. He had 50 cubic centimeters residual urine. By means of perineal prostatectomy lobes weighing 60 grams were enucleated. Pathological report: Benign hypertrophy and chronic prostatitis. The wound healed promptly. The patient was discharged on the 21st day, voiding freely, completely relieved of the pain, but the incontinence (which had followed transurethral resection) was still present. Six weeks later his general condition was excellent. Urinary control was better, but he still had a slight drip.

In the next case hypertrophied lobes weighing 62 grams were enucleated.

CASE 5. (B.U.I. 25672.) J. L. K., aged 67 years, had had marked frequency of urination for 8 years.

Fig. 3. Path. No. 9,877. Lobes enucleated perineally, and also vesical calculus, with relief of frequency and pain which followed transurethral resection 2 years previously. Weight, 81 grams. Weight of calculus in inset, 15 grams.

He had undergone 2 transurethral resections elsewhere, one 6 years and the second, 2 years before admission, but the dysuria and marked frequency continued. On examination here the prostate was greatly enlarged. The residual urine was 425 cubic centimeters. Cultures showed aerobacter. A small median lobe was present, and the lateral lobes markedly enlarged. Dr. Colston carried out perineal prostatectomy and lobes weighing 62 grams were enucleated. Pathological report: Benign hypertrophy and chronic prostatitis. The patient was discharged on the 25th day. The wound was healed and the result excellent.

In the next case hypertrophied lobes weighing 65 grams were enucleated and also multiple prostatic calculi were removed.

CASE 6. (B.U.I. 32435.) A. H., aged 61 years, had had prostatic trouble for many years, and 4 years before admission here he underwent a transurethral resection elsewhere. The result was imperfect. Occasionally the passage of sounds was required. Recently he had marked hematuria and complete retention. Examination here showed that the prostate was markedly enlarged. Cystoscopy showed a hypertrophied trigone and a markedly cellular bladder. By perineal prostatectomy I enucleated prostatic lobes weighing 65 grams. Pathological report: Benign hypertrophy, chronic prostatitis, and multiple calculi. Convalescence was satisfactory, and when the patient was discharged on the 21st day, he was voiding normally.

In the next case hypertrophied lobes weighing 69 grams were enucleated.

CASE 7. (B.U.I. 25641.) W. C., aged 60 years, underwent a transurethral resection 2 years previously because of frequency and difficulty of urination. Following the operation he had severe bleeding when he returned home, and on admission here he suffered from marked nocturia, difficulty and dribbling, and partial incontinence. Examination showed that the prostate was greatly enlarged. Culture of the urine showed escherichia. Cystoscopy disclosed no residual urine, but considerable prostatic hypertrophy was present. By perineal prostatectomy lobes weighing 69 grams were removed. Pathological report: Benign hypertrophy. The patient was discharged on the 21st day in splendid condition. Five years later he reported that he was voiding well, at normal intervals, but that the partial incontinence (which had followed the transurethral resection) was still present.

In the next case hypertrophied lobes weighing 72 grams were enucleated.

CASE 8. (B.U.I. 27450.) W. L. B., aged 64 years, had had frequency and difficulty of urination 7 years before admission here, and he underwent a transurethral resection elsewhere. The burning and dysuria, however, continued after operation. On admission here he had marked frequency and chronic epididymitis. Culture of the urine was sterile. The residual urine was 50 cubic centimeters; the bladder capacity, 200 cubic centimeters. Examination showed a greatly enlarged prostate. By perineal prostatectomy Dr. Lloyd Lewis removed a median and 2 lateral lobes in 1 piece, weighing 72 grams. Pathological report: Benign hypertrophy. The patient was discharged on the 24th day, voiding freely, with good control, and the wound was healed. On examination 18 months later his condition was excellent; he voided once at night, and had no pain, hesitation, or difficulty.

In the next case hypertrophied lobes weighing 81 grams were enucleated (Fig. 3).

CASE 9. (B.U.I. 25022.) C. S., aged 65 years, underwent a transurethral resection elsewhere nearly 2 years previously. Following the operation he had persistent burning, urgency and frequency, and nocturia 7 times. Examination here showed that the prostate was markedly enlarged and that there was a calculus in the bladder. The urine was infected. It was impossible to introduce a cystoscope because of the large vesical calculus and the greatly contracted bladder, which held only 25 cubic centimeters. Dr. Samuel A. Vest carried out perineal prostatectomy. A calculus nearly 2 inches in diameter as well as lobes weighing 81 grams were removed. Pathological report: Benign hypertrophy. The patient was discharged on the 19th day. The wound was healed. He was voiding normally and had complete urinary control. The result of the operation was excellent. Did not answer recent letter but it was not returned.

In the next case hypertrophied lobes weighing 85 grams were enucleated (Fig. 4).

CASE 10. (B.U.I. 28038.) R. C. McQ., aged 53 years, had had difficulty and frequency, which began 9 years previously. Subsequently he had pain and hematuria. Four years ago he underwent transurethral resection elsewhere, but without improvement. One month after the first operation a second transurethral resection was done elsewhere, but still the burning and pain persisted. Three years after the second resection a third was done elsewhere, following which the patient had severe hemorrhage and epididymitis. A fourth transurethral resection, performed elsewhere, was not effectual in relieving the symptoms. On admission here he complained of difficulty, hesitancy, diurnal incontinence, pain, infected urine, epididymitis, stricture of the urethra, and impotence. The prostate was not enlarged by rectum, but cystoscopy showed an anterior lobe hanging over the orifice. The residual urine was 80 cubic centimeters. Dr. Lloyd Lewis carried out perineal prostatectomy and removed 2 large lobes weighing 85 grams. Pathological report: Benign hypertrophy and chronic prostatitis. The patient was discharged on the 17th day. The wound had healed and urination was normal; the pain on urination had disappeared. Three years later he reported that urination was normal, the pain had been relieved, and his urinary control was better.

In the next case hypertrophied lobes weighing 91 grams were enucleated.

CASE 11. (B.U.I. 27616.) E. S., aged 65 years, had sudden retention of urine 3 years before admission, and required catheterization occasionally thereafter. He underwent a transurethral resection elsewhere 8 months before admission here, but he was not relieved of his symptoms. When we saw him he complained of marked dysuria, dribbling and difficulty. Examination showed a greatly enlarged prostate. He had 150 cubic centimeters of residual urine, and the bladder was contracted. The bladder capacity was 275 cubic centimeters. A large lateral and an irregular median lobe were present, along with marked bullous edema of the bladder mucosa. The urine was infected. Dr. John Dees carried out perineal prostatectomy and enucleated 3 lobes in 2 pieces weighing 91 grams. Pathological report: Benign hypertrophy and chronic prostatitis. The patient was discharged on the 16th day. The wound was healed, urinary control perfect, and he was voiding freely at intervals of 3 hours. Examination 4 years later showed that the patient was well.

2. *One or more transurethral resections elsewhere: hypertrophied lobes weighing between 100 and 200 grams enucleated.* In the first case hypertrophied lobes weighing 102 grams were enucleated.

Fig. 4. Path. No. 12,024. Lobes enucleated perineally, with relief of pain, difficulty, and incontinence which followed four transurethral resections previously. Weight, 85 grams.

CASE 12. (B.U.I. 30670.) C. A. P., aged 61 years, had frequency and burning on urination which began 11 years before admission here. A transurethral resection had been done on him 5 years ago. His symptoms were relieved for 6 months, and then returned. On admission here he had complete retention and was wearing a catheter. The prostate was greatly enlarged. The urine was infected. The residual urine was 300 cubic centimeters. I carried out perineal prostatectomy and enucleated, in 1 piece, hypertrophied lobes weighing 102 grams and measuring 3 inches in diameter. Pathological report: Benign hypertrophy. The patient was discharged on the 21st day, voiding normally. One year later he returned for examination. Urination was normal and he could go 8 hours without voiding. The urine was clear and cultures were sterile. He had coitus frequently.

In the next case hypertrophied lobes weighing 104 grams were enucleated (Fig. 5).

CASE 13. (B.U.I. 26473.) H. N. M., aged 60 years, had urinary frequency for 3 years before admission here. A transurethral resection was done elsewhere 2 years previously, but marked frequency, burning, and intermittent hematuria continued, and a second transurethral resection was done elsewhere 1 year later, but with no improvement. On admission here he complained of severe burning on urination, nocturia every 15 minutes, and occasionally hematuria. He had incontinence by night and dribbling by day. Examination showed that the prostate was very large. The urine was infected. Cystoscopy showed intravesical enlargement of both lateral lobes. In place of the median lobe there was a deep granulating area extending from the urethra into the bladder, with marked edema of the vesical mucosa, completely obscuring both ureteral orifices. By perineal prostatectomy

Fig. 5. Path. No. 10,431. Lobes enucleated perineally, with relief of frequency, hematuria, and pain which followed two transurethral resections, 2 and 1 years previously. Weight, 104 grams.

Dr. Lloyd Lewis enucleated 3 lobes weighing 104 grams. Pathological report: Benign hypertrophy and chronic prostatitis. The patient was discharged on the 31st day, voiding normally and with good urinary control. Did not answer letter but it was not returned.

In the next case hypertrophied lobes weighing 115 grams were enucleated (Fig. 6).

CASE 14. (B.U.I. 21988.) J. H. A., aged 77 years, had prostatic obstruction which was treated by a transurethral punch operation 8 years previously. Two years after the first operation another transurethral procedure was done, with no relief of symptoms. Five years later he had an attack of severe hematuria which was treated by transurethral cauterization. Two months before admission here the patient had another attack of severe bleeding, and when I saw him he complained of urgency, frequency every 1½ hours and burning. The prostate was greatly enlarged. The residual was 50 cubic centimeters and the urine was infected. On cystoscopy the median lobe had been completely removed, but 2 large lateral lobes remained. I carried out perineal prostatectomy, enucleating in 1 piece a hypertrophied mass which weighed 115 grams. Pathological report: Benign hypertrophy. In 10 days the wound was healed. The patient was discharged on the 26th day, voiding normally. On examination 1½ years later the patient voided normally. He could go 7 hours at night without urinating. Two and a half years after operation he reported by letter that urination was normal and that he had had no more attacks of hematuria.

In the next case hypertrophied lobes weighing 174 grams were enucleated (Fig. 7).

CASE 15. (B.U.I. 25109.) J. C., aged 72 years, had acute retention, for which suprapubic cystotomy was performed elsewhere. Two weeks later a transurethral resection was carried out, 56 grams of tissue being removed. Following operation the patient became delirious and began to have marked pyrexia, which continued daily. The transurethral resection failed to relieve the obstruction. The suprapubic wound opened and a second resection was performed, 16 grams of tissue being removed. After that the patient had prolonged fever and was unable to void. When I saw him the prostate was found to be greatly enlarged. He continued to have a high temperature every day. Cystoscopy showed an anterior lobe, 2 later lobes which projected into the bladder, and, behind these, evidence that much tissue had been resected. A perineal prostatectomy was carried out by Dr. Lloyd Lewis, and 2 very large lobes weighing 174 grams were enucleated. Following operation the patient had more fever and blood cultures showed a streptococcus infection. Various types of chemotherapy were employed without sterilization of the blood being obtained. The perineal wound healed in 5 weeks, and on discharge the patient was voiding normally. The daily pyrexia continued. Several weeks after leaving the hospital he died of pulmonary embolism.

3. Transurethral resection elsewhere; huge prostatic lobes weighing 235 grams enucleated.

CASE 16. (B.U.I. 32417.) W. W. H. had symptoms of prostatic obstruction 10 years previously. Nine years ago he underwent transurethral resection elsewhere. He was asymptomatic for 1 year, and then frequency, pain, and terminal hematuria developed. Recently he required catheterization, and on admission here he was suffering greatly. Rectal examination disclosed huge prostatic hypertrophy.

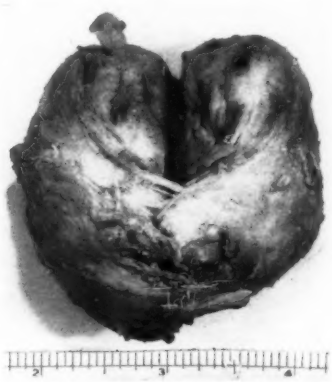

Fig. 6. Path. No. 11,379. Lobes enucleated perineally, with relief of marked frequency, burning, and hematuria which followed two transurethral resections previously. Weight, 115 grams.

The residual urine was approximately 250 cubic centimeters. Cystoscopy showed a very great enlargement of the intravesical and intraurethral prostatic lobes. I carried out perineal prostatectomy, enucleating greatly enlarged lateral and a median lobe in 1 piece weighing 235 grams (Fig. 8). Pathological report: Benign hypertrophy. The patient was discharged on the 22d day, the wound was closed, urination was normal, at intervals of 2½ hours, and he had no discomfort. Six months later the patient reported that he was well.

4. One or more transurethral resections elsewhere; hypertrophied lobes weighing less than 50 grams enucleated; but various symptoms, such as pain, irritation, burning, dysuria, straining, frequency, and calculi had followed transurethral resection. I shall cite brief abstracts of 19 of these cases.

CASE 17. (B.U.I. 24894.) S. B., aged 69 years, had been subjected to 3 transurethral resections elsewhere, yet on admission here he had 50 cubic centimeters residual urine, intractible pyuria, with chronic infection of the bladder and urethra. The tissue removed by perineal prostatectomy showed both hypertrophy and prostatitis. Although the specimen weighed only 37 grams, an excellent result was obtained, and the patient lived for 5 years in comfort. He died from a heart attack.

CASE 18. (B.U.I. 30365.) T. V. S., aged 65 years, had suffered from difficulty and frequency of urination since a transurethral resection elsewhere, 5 years previously. Prostatitis was marked in the enucleated lobes which weighed only 15 grams. It is now 2 years since operation. The urine is sterile, and the result excellent.

CASE 19. (B.U.I. 27406.) R. A. T., aged 49 years, had had frequency, urgency, and pain for 2 years following transurethral resection elsewhere. The residual urine was 50 cubic centimeters. There was no infection present and only a small amount of tissue was enucleated by a perineal prostatectomy, but the patient reported a year after operation that he had been completely relieved. Urination was normal.

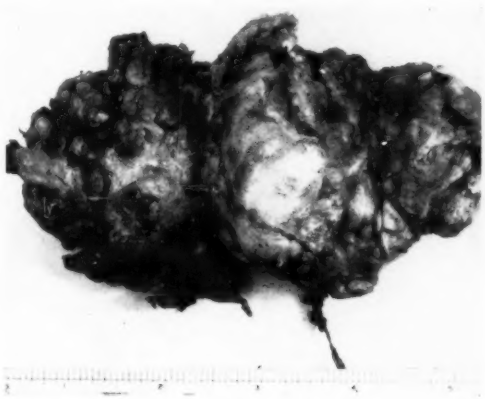

Fig. 7. Path. No. 9,874. Lobes enucleated perineally, with relief of complete retention which followed two transurethral resections previously. Weight, 174 grams.

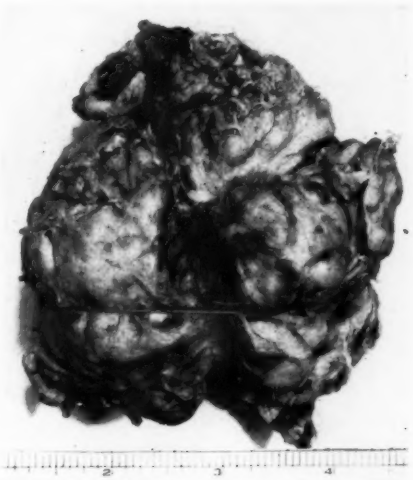

Fig. 8. Path. No. 12,613. Lobes enucleated perineally, with relief of complete retention, pain and hematuria which followed transurethral resection 9 years previously. Weight 235 grams.

CASE 20. (B.U.I. 26601.) E. Z., aged 69 years, 3 transurethral resections elsewhere had failed to give relief from marked frequency, burning, and pain. He had a pronounced urinary infection, and 150 cubic centimeters residual urine. The tissue removed weighed 45 grams and showed marked prostatitis in addition to benign hypertrophy. Four years after perineal prostatectomy the patient reported that urination was normal, that he was relieved of the pain and was well.

CASE 21. (B.U.I. 25967.) J. R., aged 57 years, 4 transurethral resections had been done, the last one 2 years previously, but the patient still had marked frequency, difficulty, and burning. Two additional transurethral resections failed to afford relief. Although there was only 25 cubic centimeters residual urine and the amount of tissue removed by perineal prostatectomy weighed only 19 grams, marked prostatitis was present in microscopic sections. The patient was completely relieved and 6 years later, his physician reported that he was enjoying splendid health and urination was normal.

CASE 22. (B.U.I. 31673.) A transurethral resection elsewhere 4 years previously had afforded only temporary relief, and he had had to resume a catheter life. The lobes enucleated perineally weighed 39 grams. The patient reported 1 year

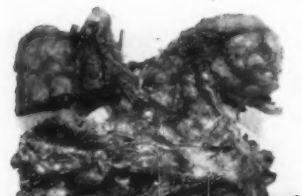

Fig. 9. Path. No. 10,469. Entire prostate and seminal vesicles enucleated by radical operation for cancer after transurethral resection 4 years previously. Weight, 73 grams.

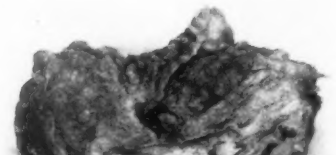

Fig. 10. Path. No. 11,110. Entire prostate and seminal vesicles removed by radical operation for cancer after transurethral resection 18 months previously. Weight, 75 grams.

after operation that he had been completely relieved and that urination was normal.

CASE 23. (B.U.I. 20513.) J. B., aged 67 years, complained of marked frequency, urgency, burning, pain, and severe urinary infection following transurethral resection elsewhere. The residual urine was 375 cubic centimeters. The lobes enucleated perineally weighed 31 grams. Microscopic sections showed marked prostatitis as well as hypertrophy. An excellent result was obtained. The patient reported that he had been completely relieved and that he was voiding normally. Did not answer letter but it was not returned.

CASE 24. (B.U.I. 21938.) C. C. H., aged 54 years, a physician, underwent transurethral resection elsewhere 2½ months prior to admission here. He said: "The operation lasted 2 hours, a handful of tissue was removed, and the bleeding lasted intermittently for 28 days. I never regained urinary control and have total incontinence when on my feet." Examination here showed that the median and left lobes had been removed along with a portion of the membranous urethra. Through a suprapubic incision I removed the remaining prostatic lobe and through the perineum a segment of the scarred urethra was excised, and a perineal muscle plastic done in an effort to cure the incontinence (8). This was partially successful. The lobe which was removed weighed 18 grams.

CASE 25. (B.U.I. 27194.) F. P. W., aged 58 years, upon whom a transurethral resection had been done elsewhere, came to me complaining of complete retention of urine. The tissue enucleated weighed 40 grams and showed prostatitis and hypertrophy. The patient was discharged on the 14th day. The ultimate result was splendid, and he reported by letter 4 years after operation that he was enjoying excellent health.

CASE 26. (B.U.I. 21882.) G. M. C., aged 70 years, continued to have marked frequency and pain following transurethral resection elsewhere, which necessitated his remaining in the hospital 5 weeks because of bleeding. The frequency, difficulty, and pain persisted. The lobes enucleated perineally weighed only 23 grams, but microscopic examination of the tissue showed prostatitis as well as hypertrophy. The immediate result was excellent, and a year after operation he reported that micturition was normal and cultures of the urine sterile.

CASE 27. (B.U.I. 17664.) A. T. S., aged 51 years, had been subjected to transurethral resection elsewhere 4 years before I saw him. The obstruction was largely removed, but he complained of urgency, nocturia 3 times, and dribbling. The enucleated lobes weighed 40 grams. Microscopic examination showed chronic prostatitis and benign hypertrophy. Two years later examination showed that micturition was normal, but the slight dribbling, which he had had since the transurethral resection, had not quite disappeared. The urine was sterile.

CASE 28. (B.U.I. 22832.) E. P. S., aged 63 years, had been subjected to 2 transurethral resections but continued to have chills and fever. Examination showed a marked infection of the bladder and prostate. He had 280 cubic centimeters residual urine. Dr. Colston enucleated prostatic lobes weighing 36 grams. Microscopic examination of the tissue showed prostatitis and benign prostatic hypertrophy. Although the patient had very severe cardiovascular lesions he went through perineal prostatectomy satisfactorily and on discharge he was greatly improved. Eighteen months later the patient reported that he voided urine freely at normal intervals.

CASE 29. (B.U.I. 27248.) C. I. R., aged 62 years, was relieved of the obstruction to urination by

transurethral resection elsewhere, 2 years previously, but severe infection, prostatitis, cystitis, and pain persisted, and he insisted that something be done to relieve him. The tissue removed by perineal prostatectomy weighed 14 grams. The convalescence was smooth and the wound healed, but 1 week after operation the patient died suddenly, apparently from coronary occlusion. No autopsy was obtained.

CASE 30. (B.U.I. 29948.) M. E. H., aged 70 years, underwent a transurethral resection 1 year previously because of marked frequency, urgency, and straining. His symptoms were relieved for a time, but then returned as severe as before the resection. On admission here he had frequency, urgency, straining, dribbling, nocturia, and burning. The prostate was moderately enlarged. Cystoscopy showed that large lateral lobes were present and also a small median lobe. The residual urine was 650 cubic centimeters. A perineal prostatectomy was undertaken by Dr. Lloyd Lewis. Owing to previous amputation of the right leg, it was impossible to get the patient in a good perineal position. In exposing the prostate the rectum was torn. The rectum was closed and perineal prostatectomy carried out. The specimen weighed 40 grams. The tissue showed benign prostatic hypertrophy. Three days after operation feces came through the perineal wound and when the urethral catheter was removed 3 days later, urine came through the perineum. On October 22, 1940, Dr. Lewis carried out the Young-Stone operation for rectourethral fistula (9). The patient was discharged 5 weeks after operation. The wound was healed and the fistula cured. The patient was voiding normally through the urethra. Patient has not answered subsequent letters.

CASE 31. (B.U.I. 24108.) W. H. B., aged 70 years, underwent a transurethral resection elsewhere because of marked difficulty and frequency of urination. Two years later the obstruction to urination returned, accompanied by marked hematuria and great frequency of urination which was present on admission here. The prostate was moderately enlarged. On cystoscopy the residual urine was found to be 200 cubic centimeters, the bladder capacity 400 cubic centimeters. Moderate lateral and median lobes were present. Perineal prostatectomy was advised, but the patient postponed operation until 2 years later, when cystoscopy showed that the lateral lobes had increased in size and a large median lobe had developed. Under spinal anesthesia I removed perineally median and lateral lobes weighing 45 grams. Pathological report: Benign prostatic hypertrophy and prostatitis. The patient was discharged in 3 weeks. The wound was healed, and he was voiding normally. He returned 4 years later. Urination was normal, his general health was excellent, and examination was negative.

Patients complaining of calculi following transurethral resection elsewhere, who were cured by perineal prostatectomy. Among the 19 cases in which the tissue removed by perineal operation weighed less than 50 grams, there were 4 cases in which either vesical or prostatic calculi were found on examination here.

CASE 32. (B.U.I. 24455.) G. A., aged 72 years, had a large calculus develop in the bladder 2 years after transurethral resection elsewhere. A suprapubic lithotomy was performed elsewhere, but the pain, frequency, and obstructive symptoms persisted. By perineal prostatectomy here 43 grams of tissue was enucleated and a large vesical calculus removed. Microscopic examination showed severe prostatitis and hypertrophy. On discharge the patient was voiding normally. Two years later the patient died from lobar pneumonia and chronic endocarditis. Operative result was apparently excellent.

CASE 33. (B.U.I. 25267.) T. de S., aged 71 years, had suffered with severe pain, frequency, and hesitation following a transurethral resection elsewhere 7 months before I saw him. A vesical calculus was discovered and removed along with prostatic lobes through the perineum. On discharge he was voiding normally. Six years later his family physician reported that he was well.

CASE 34. (B.U.I. 26096.) W. A. D., aged 66 years, underwent prostatic resection elsewhere with the Braasch-Bumpus punch instrument. The operation had to be repeated. After that he had occasional hematuria and, recently, fever, cystitis, and discomfort, but no obstruction. He had suffered from recurrent attacks of infection. X-ray films showed numerous prostatic calculi. By perineal prostatectomy I enucleated the lateral lobes of the prostate along with numerous calculi through bilateral incisions. The tissue weighed 15 grams. Microscopic study showed benign hypertrophy and chronic prostatitis. He was discharged in 4 weeks, voiding normally, without pain or discomfort. He had good urinary control. Five years later the patient reported by letter that he was well.

CASE 35. (B.U.I. 28477.) D. R. McC., aged 57 years, underwent a transurethral resection elsewhere 4 months before I saw him. The operation failed to relieve him of severe pain. Examination showed numerous prostatic calculi and chronic prostatitis. Through the perineum I exposed the prostate, and glandular tissue which weighed 10 grams was excised along with numerous calculi. The immediate result was excellent. Micturition became normal. When the patient was discharged on the 45th postoperative day, he was almost free from pain from which he had suffered so severely.

In other patients (Cases 2, 6, 9) vesical calculi also were removed.

ANALYSIS OF CASES REPORTED HERE

It may be objected that in many of these cases, the patient could have been successfully treated by a more extensive and skilful

transurethral resection instead of by prostatectomy. In many of these, however, experienced operators had failed to obtain satisfactory results by one, two, and sometimes three transurethral resections; in others the prostate was so markedly enlarged that to remove all or nearly all of the hypertrophied lobes by transurethral resection would have required a prolonged resection, and, in a few cases, probably several resections. In these cases, exposure of the prostate through the perineum and relatively quick enucleation, completely removing all the hypertrophied tissue, and a surgical closure of the wound by anastomosing the mucosa at the vesical neck with the urethra below seemed to be so much more scientific that the open operation was chosen. The good results justified the choice.

In other cases, in which the remaining prostatic obstruction was not very great, transurethral resection might have been successfully repeated (although in some instances two or more already had been done elsewhere). In the majority of these patients the principal symptoms were dysuria, pain, burning and pyuria, resulting from chronic infection, and, in many cases, severe prostatitis was present. Removal of the infected tissue as well as the obstruction seemed preferable to another resection, and the results have justified the choice.

5. Analysis of 87 cases in which various symptoms persisted after transurethral resection elsewhere, but prostatectomy was not done here. The time elapsed since transurethral resection elsewhere was: under 6 months, 12 cases; between 6 and 12 months, 12 cases; between 12 and 18 months, 14 cases; between 18 months and 2 years, 15 cases; between 2 and 3 years, 12 cases; between 3 and 4 years, 8 cases; between 4 and 5 years, 8 cases; between 5 and 6 years, 7 cases; between 6 and 7 years, 2 cases; over 7 years, 6 cases.

The immediate results obtained by transurethral resection were stated in the history in 63 cases: improved, 33 cases; not improved, 30 cases.

The symptoms of which the patient complained on admission to the Brady Urological Institute were: marked frequency of urination, 54 cases; difficulty of urination, 33 cases; urgency of urination, 17 cases; pain, principally in the urethra and bladder, 29 cases; burning in the urethra or bladder, 28 cases; hematuria, 7 cases; dribbling (not amounting to true incontinence), 8 cases; complete incontinence, 6 cases.

The effects on the sexual powers were tabulated in some of the cases. One patient was completely impotent; 7 said that there was no ejaculation accompanying the orgasm; 5 complained that coitus was markedly impaired: 3 had pain on ejaculation; in 3 cases the ejaculatory ducts were found to be strictured on probing them through the urethroscope. One complained of painful erections.

The size of the prostate was definitely stated in 69 cases. On rectal examination it was described as "enlarged" in 25 cases, "slightly enlarged" in 27 cases, "moderately enlarged" in 10 cases, "considerably enlarged" in 5 cases, and "very greatly enlarged" in 1 case. Induration of the prostate was a pronounced feature in 19 cases.

In many cases it was impossible to get prostatic secretion by massage, but in 25 cases markedly purulent secretion was obtained.

Stricture of the urethra was noted in 7 cases.

Cystoscopy was carried out in 64 cases. No residual urine was found in 30 cases; from 20 to 49 cubic centimeters, 6 cases; 50 to 99 cubic centimeters, 8 cases; over 1,000 cubic centimeters, 1 case. The bladder capacity was noted in 23 cases. In 2 cases it was reduced to 100 cubic centimeters; in 4 cases to 200 cubic centimeters; in 17 cases it was over 300 cubic centimeters. A description of the cystoscopic appearance of the vesical neck or the prostatic urethra is available in 32 cases. In 4 there was no evidence of obstruction. In 1 there was a pronounced contracture. In 14, one or more definitely obstructive prostatic lobes was discovered, and in 6, very considerable lobular enlargements were seen. In 7 cases it was merely noted that obstruction at the vesical orifice remained following transurethral resection.

Cultures were not always made from the urine. In 17 the cultures were pronounced sterile. In 17 it was simply noted that infection was present. In 23 cases a pronounced

infection was discovered; and in 5 very severe infection was revealed by the cultures. The infecting agent was bacillary in character in the majority of cases, the colon group predominating. In many cases Bacillus proteus, and in a number of cases pyocyaneus was the most important organism. Staphylococci and streptococci were often present in conjunction with bacilli, but were sometimes alone. Stones were discovered in the prostate in 3 cases.

Large vesical diverticula were present in 1 case.

In 16 cases 2 transurethral resections had been carried out before the patient was admitted to our clinic. In 2 cases the fourth resection had been done without benefit. In 4 cases transurethral resection to effect a cure of the obstruction, which we found present, was carried out at our clinic.

Suprapubic drainage had been done on 4 patients either before or after transurethral section elsewhere.

In 1 case the patient complained of very severe vesical pain. Pronounced bullous edema was discovered on cystoscopy. In 5 other cases severe inflammatory conditions of the bladder were present, usually an unhealed ulcer at the neck of the bladder and trigone. In 1 case submucous ulcers requiring resection were present. In 1 case presacral neurectomy also was carried out with good result.

Summary. These 87 patients, who had been subjected to 1 or more transurethral resections elsewhere, came to us with various complaints, the most common being frequency of urination in approximately 70 per cent, and pain or severe burning in 72 per cent. Difficulty of urination was present in 37 per cent. In many cases the local symptoms were distressing and often caused by severe infection of the bladder and urethra; in other cases, pain and burning due to inflammation in the remaining prostatic tissue, which often had been incompletely resected, were responsible for many of the symptoms. These often were associated with frequency and difficulty that sometimes were so severe as to cause marked discomfort. Transurethral resection had been effective in doing away with residual urine in 34 per cent. Among the 64 patients upon whom cystoscopy was performed, about 46 per cent showed no residual urine. In 54 per cent residual urine was present, varying from 50 to 150 cubic centimeters in over half of these cases and reaching somewhere between 300 and 1000 cubic centimeters in 9 cases (14 per cent).

6. Twenty-six cases of cancer of the prostate; 1 or more transurethral resections elsewhere; lesion too far advanced on admission here for the radical operation. Five of these patients had been subjected to 2 transurethral resections; 1 to 4 resections. In 8 cases from 1 to 8 years had elapsed since the resection. It seems evident that during this period of time a careful rectal examination should have revealed cancer of the prostate early enough for the radical operation.

In many of these cases the patients obtained temporary or prolonged improvement, but in 13 cases no improvement apparently followed transurethral resection, and 1 patient became worse. On admission here 3 patients appeared to be completely relieved of symptoms. They were sent by their physicians to see whether a radical operation was possible.

In 18 cases the patient complained of marked frequency of urination; in 11, difficulty; in 7, urgency; in 2, catheterization was necessary. In 10 cases severe pain, localized in the urethra, bladder or prostate was present. In 9 cases referred pains, generally in the back, were present. In 4 cases marked burning on urination occurred; in 6 cases hematuria was a prominent symptom and in 3 cases, pyuria. The patient complained of dribbling in 3 cases, and in 4 cases complete incontinence was present. On rectal examination the whole prostate was involved in 24 cases. In 2, only a portion of the prostate was involved. The seminal vesicles were involved in 22 cases, the periprostatic tissue in 10 cases, the membranous urethra in 13 cases. Enlarged glands were made out high up in the pelvis in 2 cases. The rectum was invaded in 3 cases. In one of these a rectourethral fistula was present. Stricture of the urethra was noted in 1 case, but probably was present to a certain extent in many other cases. In 7 cases the resectionist was surprised to find cancer in the microscopic examination of sec-

tions from the tissue removed by transurethral resection. Examination of all these patients showed that they were too far advanced for radical operation when they came to us. Other cases in which the carcinoma was not so advanced and in which we thought it would be possible to obtain cures by my radical operation are not included here, but are reported farther on in this paper. An x-ray picture was not taken at our clinic in a considerable number of cases in which the carcinoma was found to be very extensive. In 7 cases an x-ray examination showed no evidence of metastasis. In 5, metastasis to the bones was present and in 2 cases the bony changes were suspicious. In some cases no treatment was given to the patient at our clinic. In 1 case radium was administered to the carcinomatous prostatic urethra by means of an applicator. In 4 cases 1 or more courses of deep x-ray therapy were given. In 7 cases orchidectomy was done. In 4 cases another transurethral resection to remove obstructions were carried out at our clinic. Two cases, in which 2 transurethral resections had been done elsewhere, but in which we discovered carcinoma of the bladder (and not of the prostate) are omitted from this list. One of these patients was subjected to ureteral transplantation and total cystectomy and prostatectomy, with improvement for several months.

7. *Cases previously treated by transurethral resection elsewhere; cancer of prostate found in microscopic examination of tissue; cases thought not too advanced for cure by radical operation, which was done.* In this group there are 4 cases of cancer of the prostate in which we decided to carry out my radical operation with the hope either of obtaining a radical cure or at least removing the carcinomatous mass and affording the patient relief from distressing obstructive symptoms and possibly freedom from local recurrence.

Case 36. (B.U.I. 25485.) M. H. B., aged 50 years, had had frequency and urgency for 1½ years. Eight weeks previously he underwent transurethral resection elsewhere. Sections revealed cancer. Examination here showed the prostate to be slightly enlarged, the right lobe irregular and very hard, the right vesicle involved, and the prostate fixed. Young's radical operation for cancer of the prostate was carried out, removing in 1 piece the prostate with its capsule, a portion of the membranous urethra, a cuff of the bladder, both seminal vesicles and the ampullae. The bladder was anastomosed to the stump of the membranous urethra. Pathological report: Cancer of prostate involving seminal vesicles. The prognosis for radical cure was poor. The wound healed promptly. The patient had almost complete urinary control on discharge. Four months later rectal examination showed no local recurrence or obstruction and normal urination, but an x-ray picture disclosed bony metastases. The patient died a year later. The radical operation had afforded complete local relief and a comfortable life for 1 year.

Case 36. (B.U.I. 26622.) E. B., aged 63 years, had had difficulty and frequency for 7 years. He underwent transurethral resection elsewhere 4 years ago, with temporary relief. On admission here he had marked hesitancy and straining. The prostate was moderately enlarged and very hard. The seminal vesicles apparently were negative. An x-ray film showed no evidence of metastases. Dr. Wyland Leadbetter carried out a radical perineal prostatectomy (Fig. 9). Pathological report: Cancer, apparently not involving the seminal vesicles. The prognosis was favorable for a radical cure. Convalescence was satisfactory. The patient voided naturally on the 15th day, the wound was dry on the 20th day. The next day he was discharged. He was voiding urine at normal intervals with good control. Two years later the patient was apparently well.

Case 37. (B.U.I. 28491.) T. E. S., aged 67 years, had obstructive symptoms 18 months previously. Complete urinary retention developed and a transurethral resection was done elsewhere. The patient was much improved until a short time before admission here, when he had marked difficulty and complete retention, requiring catheterization. On examination the prostate was only slightly enlarged, but very hard, of third degree induration. Diagnosis: Cancer of prostate, not involving the seminal vesicles and membranous urethra. X-ray films were negative for metastases. Dr. John E. Dees carried out radical perineal prostatectomy (Fig. 10). Microscopic examination of the tissue showed cancer. Convalescence was satisfactory. There was never any leakage through the perineum. He was discharged in 4 weeks, voiding normally, with almost complete control. Two months later he was voiding freely with good urinary control. Three years later he reported by letter that he was well and working every day on his farm.

Case 38. (B.U.I. 29012.) D. M. O., aged 62 years, had hesitancy and difficulty of urination a year before admission here. Six months ago he experienced marked difficulty in urinating. He consulted a distinguished resectionist who carried out a transurethral prostatectomy with the Thompson punch instrument, at which 15 grams of tissue were said to have been removed. The patient was told that microscopic examination showed cancer. Deep

x-ray therapy was instituted. The patient saw me at a meeting of the Interstate Post-Graduate Assembly in Chicago in October, 1939. Examination showed third degree induration of the entire prostate, evidently cancer. The radical operation was advised. I carried out radical removal of the prostate with the seminal vesicles and neck of the bladder. Pathological report: Adenocarcinoma of the prostate; the seminal vesicles apparently were not involved. Postoperative phlebitis kept the patient in the hospital 6 weeks. On discharge he was voiding normally through the urethra at intervals of 3 hours. He had slight incontinence which had been present since the transurethral resection. Three years later the patient reported by letter that he was well. He was voiding urine with good control, but a few drops leaked on coughing or sudden movement.

SUMMARY

This paper is not intended to present a complete picture of the results obtainable by transurethral resection. We have in the records of the Brady Urological Institute hundreds of case histories which testify to the relief of obstruction, frequency, difficulty, pain, and other symptoms presented by patients who have been successfully treated by transurethral prostatic resection either with my cold-cutting punch or one of its modifications, or with the electric resectoscope of McCarthy. The cases reported here are of those patients who complained of unsatisfactory results after one or more transurethral resections elsewhere.

I have first described those cases in which prostatic lobes had been left behind or developed after transurethral resection, removal of which by perineal prostatectomy afforded relief of the symptoms of which the patient complained. In some of these the transurethral operations had been manifestly inadequate. Often only the middle lobe was thoroughly resected and the laterals were incompletely removed. In many instances, however, the patients had obtained relief of obstruction for a time, but the remaining portions of the hypertrophied lobes continued to grow and ultimately produced marked obstruction to urination and other distressing symptoms.

In other cases these symptoms were greatly aggravated by the presence of infection, not only of the bladder and urethra, but of the remaining prostatic tissue. Chronic prostatitis appeared to be a frequent sequel of transurethral resection, and in most instances resisted all efforts at sterilization by modern chemotherapy, including the various sulfonamides. Annoying burning in the urethra or vesical neck, aggravated during micturition and sometimes amounting to severe pain, frequently was present.

In some cases in which no residual urine was found, the irritation was sufficient to produce very frequent micturition and even dysuria. In such cases a second and even a third transurethral resection had failed to do away with the distressing symptoms which followed the first resection.

In a few cases chronic ulceration of the floor of the urethra, extending back into the bladder, had persisted for many months after transurethral resection and occasionally was associated with bullous edema and an irritable, contracted bladder, in one case so severe that presacral neurectomy was necessary to afford relief.

In another case resection of the ulcerated portions of the bladder, in addition to presacral neurectomy, was required.

In a few cases vesical calculi were present, having recurred in one case after a second resection and removal of the stones. In some cases calculi in the tissue of the prostate gland itself were responsible for marked discomfort and the persistence of pyuria and infection. Perineal prostatectomy, by affording an opportunity to remove completely the stone-bearing prostatic tissue, finally gave complete relief.

A number of these patients had not been relieved by a second transurethral resection elsewhere but were promptly cured by enucleation of the obstructing infected lobes through the perineum. In some, equally good results might have been obtained by suprapubic enucleation. To have attempted again, by transurethral resection, to do a complete removal of the large prostatic lobes would have consumed a great deal of time and resulted in an incomplete operation, whereas much less time was required to do a thorough enucleation through the perineum, and by drawing down the mucosa below the vesical neck and suturing it to the remaining urethra, prac-

tically *per primam* healing was obtained, affording prompt restoration to normal micturition. Most striking is the fact that pyuria and severe persistent infection generally disappeared with the removal of the chronically infected and obstructive prostatic lobes.

These cases seem to prove conclusively that in prostates of considerable size, and even in some of moderate size, an enucleating prostatectomy is a far more scientific procedure than chipping away the periurethral prostate bit by bit, and rarely removing all the adenomatous lobes completely. In some of these cases, even by prolonged transurethral procedures, it would have been impossible to remove the portions of the very large adenomatous lobes remote from the urethra, especially those which extended well beneath the trigone. To have attempted a complete removal in the latter cases by transurethral resection would have necessitated destruction of a large part of the trigone, a condition which Rudnick showed to be sometimes the cause of a fatal ending.

But it is in the carcinomatous prostate that the routine use of transurethral resection in all cases with prostatism has its most direful results. In most of the cases of cancer reported here, a considerable period had elapsed between the transurethral resection and the time that the patient came to us, with cancer of the prostate too advanced for the radical operation. In these cases the histories frequently disclosed that the patients had been treated for months before being subjected to a transurethral operation. A careful rectal examination should have warned of the presence of cancer at a time when it was well confined within the capsule of the prostate, and the radical operation could have been carried out successfully. Even if the examination only aroused the suspicion of cancer, by means of a perineal exposure and biopsy, accurate determination as to the presence of cancer could have been obtained and an appropriate operation done.

Previously in SURGERY, GYNECOLOGY AND OBSTETRICS I described in detail the latest technique which I employ in the radical operation for cancer of the prostate. A careful review of all cases subjected to this operation at our clinic shows that the technique is not difficult, inasmuch as splendid results have been obtained by house officers doing their first prostatectomies; in fact, their record is almost the best of the staff. The operation itself, in patients in anything like fair condition, is relatively free from danger. We have had one series of 53 consecutive cases without a death, and the operative mortality for all cases is 6 per cent. Incontinence no longer is a bugbear. By more careful placing of sutures between the bladder and the stump of the membranous urethra, so as not to ligate the musculature of the external sphincter, normal micturition is obtained.

Reports from various clinics substantiate our claims that, taken early, cancer of the prostate is curable by the radical operation. In cases in which even the entire prostate was carcinomatous, and including those in which a small portion of the adjacent seminal vesicles were involved, radical cures have been obtained in over 50 per cent of our cases followed 4 years or longer.

When these facts are more widely appreciated by the medical profession, many more cases of cancer of the prostate will be sent to competent urological surgeons sufficiently early for a radical cure. An encouraging sign is that already some general practitioners are recognizing that a very markedly indurated area in the prostate should be suspected of being malignant.

CONCLUSIONS

I believe a fair conclusion to be drawn from this study of the 200 patients who were subjected to one or more transurethral resections before coming to us is that for many cases, particularly those with considerably enlarged prostates, complete enucleation of the hypertrophied lobes through the perineum gives better results and is no more dangerous than transurethral resection.

Prostatitis and painful urination are certainly less common after perineal prostatectomy than after transurethral resection.

Another great advantage of the perineal procedure is the opportunity which it affords to make a diagnosis and effect a cure of carcinoma of the prostate.

Undoubtedly many conditions, particularly bars, contractures and small hypertrophies, can be dealt with efficiently by transurethral resection. But in the larger hypertrophies, the patients with calculi in the prostate, and those with chronic prostatitis, my study of 200 cases shows that perineal prostatectomy is distinctly superior.

Prostatism is so complex in its symptoms and so varied in its pathology that it can be handled satisfactorily only by careful selection of the operative procedure best suited to obtain a radical cure.

The exclusive use of transurethral resection for all types of prostatic obstruction, even the very large and the malignant, is indefensible.

REFERENCES

1. Hinman, Frank. J. Am. M. Ass., 119, 669: 1942.
2. Rudnick, Dorrin F. J. Urol., 1935, 34: 437–445.
3. Smith, George Gilbert. J. Am. M. Ass., 1942, 118: 1514.
4. Young, Hugh H. Tr. Am. Ass. Genito-Urin. Surg., 1909, 4: 134–145: 152–153.
5. Idem. Transurethral resection of the prostate: A clinical and operative study, with exhaustive quotations from the literature. In Nelson's Loose-Leaf Surgery, 1937.
6. Idem. Surg. Gyn. Obst., 1937, 64: 472–484.
7. Idem. J. Am. M. Ass., 1942, 119: 669.
8. Idem. Surg. Gyn. Obst., 1919, 28: 84-90.
9. Young Hugh H. and Stone, Harvey B. Tr. Am. Ass. Genito-Urin. Surg., 1913, 8: 270-278. Also J. Urol., 1917, 1: 289-317.

METABOLIC STUDIES IN PATIENTS WITH CANCER OF THE GASTROINTESTINAL TRACT

XI. Postoperative Hypoproteinemia and Relationship of Serum Protein Fall to Urinary Nitrogen Excretion

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IN a previous investigation of this series (3) a high incidence of hypoproteinemia was found in patients with gastric cancer. In most instances this abnormality was due to an impaired albumin fabrication, apparently induced by the presence of the tumor. The existence of hypoproteinemia in these patients was considered to be of noteworthy importance because they usually undergo prolonged surgical procedures. The postoperative complications which result from the hypoproteinemic state are known to include tissue edema (8), gastrointestinal hypomotility (4), increased susceptibility to infection (6), and poor wound healing (10).

During the last few years it has been the clinical experience of this hospital that the postoperative complications attributable to hypoproteinemia were encountered more frequently in patients with gastrointestinal cancer than in individuals with other disorders. This observation suggested that patients with cancer of the gastrointestinal tract were more prone to develop after operation seriously low levels of serum protein, although the reason for that tendency was not apparent. Accordingly the present study was undertaken in order to ascertain whether or not (a) the serum protein levels of patients with gastrointestinal cancer fell after operation more frequently and to lower levels than did those of other groups of patients subjected to comparable surgical manipulation, and (b), if this were so, was an increased protein catabolism responsible.

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CLINICAL MATERIAL

Three groups of patients were studied. In all, the diagnosis was confirmed by microscopic examination of biopsy sections.

Group I consisted of 47 patients with gastrointestinal cancer. Of these 3 had carcinoma of the esophagus, 36 of the stomach, 1 of the duodenum, 1 of the sigmoid, and 6 of the rectum. These patients were subjected to operative procedures which ranged in their gravity from simple laparotomy to complete resection.

Group II consisted of 9 patients with benign, non-neoplastic disease of the gastrointestinal tract. Four had gastric ulcer, 3 suffered from gastritis, and 2 with duodenal ulcers.

Group III consisted of 9 women with gynecologic disorders. Of these, 2 had cancer of the uterus, 5 had uterine fibroids, 1 had a dermoid cyst, and the last had a fibroid of the ovary. Seven were subjected to supracervical hysterectomy and 2 underwent oophorectomy.

METHODS

A. Clinical. All determinations of serum protein were made in duplicate on samples obtained from patients who were fasting and who were considered not to have hemoconcentration.

All the patients with gastrointestinal disorders were hospitalized for from 5 to 10 days before they were subjected to operation. During this time they were maintained on constant diets and were given from 2,000 to 3,500 milliliters of fluids daily. In the first 5 days after operation these individuals ingested *a total* of from 1,000 to 5,000 calories and from 35 to 150 grams of protein.

TABLE I.—EFFECT OF OPERATION UPON THE SERUM PROTEIN CONCENTRATION AND THE URINARY NITROGEN IN PATIENTS WITH GASTROINTESTINAL CANCER

Patient	Site of cancer	Operation	Preoperative serum protein concentration gm. per cent	Maximum change of serum protein level during first 5 postoperative days—gm. per cent	Average daily urinary nitrogen during first 5 postoperative days gm.
R.J.	Esophagus	Thoracotomy	7.3	1.1	6.5
J.M.	Esophagus	Resection of terminal esophagus and cardiectomy	6.0	−0.4	6.9
J.M.	Esophagus	Esophagectomy	6.0	−0.1	12.8
A.A.	Stomach	Gastrostomy	6.1	−0.1	8.8
F.B.	Stomach	Total gastrectomy	6.2	−0.7	9.8
S.B.	Stomach	Jejunostomy	5.5	0.0	8.0
A.B.	Stomach	Subtotal gastrectomy	6.6	−0.8	—
A.D.	Stomach	Exploratory laparotomy	6.6	−1.5	—
T.C.	Stomach	Jejunostomy	6.0	−0.9	—
C.F.	Stomach	Exploratory laparotomy	6.1	−0.9	—
S.F.	Stomach	Exploratory laparotomy	6.3	−0.3	11.0
T.F.	Stomach	Subtotal gastrectomy	7.1	−0.9	—
T.G.	Stomach	Subtotal gastrectomy	4.8	−0.3	—
H.G.	Stomach	Exploratory laparotomy	6.6	−1.0	8.5
P.G.	Stomach	Exploratory laparotomy	6.0	−0.7	9.2
A.H.	Stomach	Subtotal gastrectomy	7.2	−2.0	6.0
F.G.	Stomach	Subtotal gastrectomy	6.8	−0.3	—
S.H.	Stomach	Exploratory laparotomy	6.5	−0.1	—
W.J.	Stomach	Exploratory laparotomy	5.8	−0.3	6.7
M.K.	Stomach	Exploratory laparotomy	6.1	−0.5	7.5
F.K.	Stomach	Subtotal gastrectomy	7.1	−0.5	—
F.K.	Stomach	Gastroenterostomy	6.8	−1.0	—
L.L.	Stomach	Subtotal gastrectomy	5.0	−1.0	7.6
F.M.	Stomach	Exploratory thoracotomy	6.5	−0.7	16.8
M.P.	Stomach	Exploratory laparotomy	6.5	−0.7	12.6
J.S.	Stomach	Exploratory laparotomy	5.8	0.0	—
E.P.	Stomach	Gastrostomy	7.0	−0.7	—
R.P.	Stomach	Subtotal gastrectomy	7.0	−1.9	9.8
F.R.	Stomach	Subtotal gastrectomy	6.7	0.0	—
L.R.	Stomach	Total gastrectomy	7.1	0.0	—
D.S.	Stomach	Exploratory laparotomy	5.6	+0.5	6.7
J.S.	Stomach	Exploratory laparotomy	6.7	−0.5	—
D.S.	Stomach	Gastroenterostomy	6.5	−1.1	8.8
T.V.	Stomach	Exploratory laparotomy	6.0	−0.6	—
J.T.	Stomach	Subtotal gastrectomy	6.7	−1.5	6.2
R.Y.	Stomach	Exploratory thoracotomy	6.8	−1.4	10.0
S.W.	Stomach	Exploratory laparotomy	4.6	+0.2	11.5
J.Y.	Stomach	Subtotal gastrectomy	6.9	−1.7	9.0
E.Y.	Stomach	Exploratory laparotomy	7.2	−0.5	—
M.P.	Duodenum (Ampulla of Vater)	Duodenectomy, cholecystogastrostomy	6.5	−0.1	11.0
D.R.	Sigmoid	Drainage of a perisigmoid abscess	6.8	−0.5	8.0
J.G.	Rectum	Resection sigmoid	6.6	−0.7	6.9
E.K.	Rectum	Rectal resection	6.5	−0.5	8.8
J.M.	Rectum	Colectomy	7.5	−0.9	12.0
O.R.	Rectum	Rectal resection	7.3	−1.7	9.6
J.S.	Rectum	Rectal resection	6.8	−1.7	7.2
A.A.	Rectum	Rectal resection	6.7	−0.7	9.3
Average			6.31		8.96

The patients with gynecologic disease were hospitalized for from 1 to 4 days before operation. They received in that interval, and after operation, the same diets and amounts of fluids given to the patients with gastrointestinal disorders.

For 5 days after operation, the total urine was collected from most of the patients studied. These were obtained in 24 or 48 hour samples and during the periods of collection were kept at a hydrogen-ion concentration of about pH 1, with sulfuric acid, in order to prevent loss of ammonia.

B. Chemical. The concentrations of serum protein were determined by the method of Weech and associates. The urinary nitrogen was measured by the micro-Kjeldahl technique (9).

RESULTS

The preoperative concentrations of serum protein in the 47 patients with gastrointestinal cancer ranged from 4.6 to 7.5, and averaged 6.31 grams per cent (Table I). Of these

TABLE II.—EFFECT OF OPERATION UPON THE SERUM PROTEIN CONCENTRATION AND THE URINARY NITROGEN IN PATIENTS WITH NON-NEOPLASTIC DISEASE OF THE GASTRO-INTESTINAL TRACT

Patient	Diagnosis	Operation	Preoperative serum protein concentration gm. per cent	Maximum change of serum protein level during first 5 postoperative days gm. per cent	Average daily urinary nitrogen during first 5 postoperative days gm.
A.D.	Gastric ulcer	Subtotal gastrectomy	6.6	0.0	8.0
A.G.	Gastritis	Exploratory laparotomy. Biopsies of gastric mucosa and of liver	7.1	−0.2	13.8
R.G.	Gastric ulcer	Subtotal gastrectomy	6.2	−0.1	8.4
J.S.	Gastric ulcer	Subtotal gastrectomy	6.7	−0.2	5.3
H.K.	Follicular gastritis	Subtotal gastrectomy	7.0	−0.3	9.0
J.G.	Duodenal ulcer with obstruction	Subtotal gastrectomy	6.6	+0.1	10.5
G.F.	Gastritis	Exploratory laparotomy	5.9	−0.1	8.43
T.B.	Gastric ulcer	Subtotal gastrectomy	6.8	−0.2	—
L.P.	Duodenal ulcer	Exploratory laparotomy	6.0	+0.4	—
Average			6.54		8.90

TABLE III.—EFFECT OF OPERATION UPON THE SERUM PROTEIN CONCENTRATION AND THE URINARY NITROGEN IN PATIENTS WITH GYNECOLOGICAL DISORDERS

Patient	Diagnosis	Operation	Preoperative serum protein concentration gm. per cent	Maximum change of serum protein during first 5 postoperative days gm. per cent	Average daily urinary nitrogen during first 5 postoperative days gm.
M.B.	Fibromyoma	Supracervical hysterectomy	7.6	−0.1	5.22
E.C.	Fibromyoma uteri	Supracervical hysterectomy	6.8	−0.3	5.75
D.H.	Dermoid cyst	Resection of cyst, appendectomy	6.7	+0.2	4.89
L.H.	Fibromyoma uteri	Supracervical hysterectomy, appendectomy	6.8	−0.2	10.29
L.M.	Fibromyoma uteri	Supracervical hysterectomy	6.3	−1.1	3.24
A.S.	Fibromyoma uteri	Total hysterectomy, appendectomy, bilateral salpingectomy	6.2	+0.1	11.08
M.S.	Fibroma of ovary	Bilateral salpingo-oophorectomy	5.9	+0.1	3.77
R.L.	Carcinoma corpus uteri	Total hysterectomy, bilateral salpingectomy	6.4	0.0	8.77
R.L.	Adenoma malignum of corpus uteri	Total hysterectomy, bilateral salpingectomy, appendectomy	6.7	−0.2	10.35
Average			6.61		7.04

individuals, 23 were hypoproteinemic. During the first 5 postoperative days 41 developed hypoproteinemia. The serum protein concentrations fell in 40 of the 47 patients studied. The average decrease in these instances was 0.81 and the range of decrease from 0.1 to 2.0 grams per cent. In the remaining 7 patients the serum protein concentrations after operation either remained constant or increased from 0.2 to 0.5 gram per cent.

During this 5 day postoperative period, the total urine was collected from 30 of the 47 patients studied. The average daily urinary nitrogen excreted by each of these individuals ranged from 6.0 to 16.8 grams and the average of the group was 8.96 grams per day. These values of nitrogen excreted indicate that probably from 187.5 to 525. grams of protein (average 280.0 gms.) were catabolized by the patients with gastrointestinal cancer during the first 5 days after operation. Since these individuals had received during this same period only from 35 to 150 grams of protein (average 85 gm.), they apparently sustained after operation a significant amount of tissue breakdown. No correlation could be obtained between the decreased concentrations of serum protein and the amounts of nitrogen excreted by the patients of this group.

As control material for the observations just described, similar studies were made in 2 other groups of patients. The first of these consisted of 9 patients with non-neoplastic disorders (Table II) who were submitted to surgical procedures similar to those to which were subjected the patients with gastrointes-

tinal cancer. The results obtained in the patients with non-neoplastic gastrointestinal disease form an interesting contrast to those of the patients with cancer.

The preoperative concentration of serum protein in the patients with benign gastrointestinal disease ranged from 5.9 to 7.1 grams, and averaged 6.54 grams per cent. Of these 9, 3 were hypoproteinemic.

When these individuals were subjected to surgery their serum protein levels fell in 6 instances from 0.1 to 0.3 gram, average 0.18 gram per cent. In 1, no change in the serum protein concentration was noted, and in the remainder these concentrations increased by from 0.1 to 0.4 gram per cent in that period. After operation, 4 of the 9 patients were hypoproteinemic. However, although no significant decrease in the concentrations of serum protein was observed in these individuals, nevertheless, they excreted during the first 5 postoperative days an average of from 5.3 to 13.8 grams of urinary nitrogen per day (average 8.90 grams per day). It is to be noted that these amounts of urinary nitrogen are about the same as those excreted by the patients with gastrointestinal cancer who did develop hypoproteinemia. As in the latter group, no correlation could be made between the postoperative levels of serum protein and the amounts of urinary nitrogen excreted.

The second control group of patients investigated were 9 women subjected to gynecologic surgery. It was believed that this study would provide data of the effects on protein catabolism of intra-abdominal operations other than those on the gastrointestinal tract. The preoperative concentrations of serum protein of these 9 patients ranged from 5.9 to 7.6 grams, and averaged 6.61 grams per cent. Of these 4 had abnormally low levels. Within 5 days after operation the concentration of serum protein fell in 5 by from 0.1 to 1.1 grams. The average decrease of these 5 patients was 0.38 gram per cent. The concentration of serum protein did not change in 1 instance, and increased from 0.1 to 0.2 gram per cent in the remaining 3 patients.

The average daily amounts of nitrogen excreted by the patients with gynecologic disorders during the first 5 postoperative days ranged from 3.24 to 10.35 grams, and averaged 7.04 grams. As in the other 2 groups of patients studied, no correlation could be made between the amounts of urinary nitrogen excreted and the amounts by which the serum protein concentrations decreased. It is of considerable importance to note, however, that although the 2 control groups of patients lost after operation an average of 7.04 and 8.90 grams of urinary nitrogen per day, and the patients with gastrointestinal cancer excreted 8.96 grams per day, the average maximum change in the concentration of serum protein in the patients with gastrointestinal cancer in whom those levels decreased was 0.81 gram per cent, whereas that of all of the 2 control groups decreased 0.18 and 0.38 gram per cent (Table IV).

TABLE IV.—EFFECT OF OPERATION UPON THE SERUM PROTEIN CONCENTRATION IN PATIENTS WITH DIFFERENT DISEASE PROCESSES AND THEIR EXCRETION OF URINARY NITROGEN

Patients with	Number of patients	Preoperative serum protein concentration gm. per cent	Average maximum drop in serum protein level during first 5 postoperative days—gm. per cent	Per cent of patients whose serum protein dropped postoperatively	Average daily urinary nitrogen during first 5 days postoperative gm.
Gastrointestinal cancer	47	6.31	0.81	84	8.96
Non-neoplastic disease of the gastrointestinal tract	9	6.54	0.18	67	8.90
Gynecologic disorder	9	6.61	0.38	55	7.04

ANALYSIS OF STUDY

Not only are the concentrations of serum protein in patients with gastrointestinal cancer low before operation, but those levels now have been found to fall to still further abnormally low limits after operation. There is now reason to believe that the hypoproteinemic state developed after operation chiefly is responsible for the high incidence among these patients of wound disruption (2), disturbed electrolyte equilibrium (1, 7), and of their adynamic ileus, gastrointestinal and peripheral edema (2). Because of the development of these serious postoperative complications the existence of hypoproteinemia in

patients with gastrointestinal cancer becomes of considerable importance.

Although both the patients with gastrointestinal cancer and those of the 2 groups used as controls all excreted after operation comparably equal amounts of urinary nitrogen, only the first group of individuals sustained considerable reductions of their serum protein levels. The explanation for this observation probably is that (a) the tissue protein stores of patients with cancer of the gastrointestinal tract are depleted and, therefore, cannot restore the serum protein concentrations to their preoperative levels, and (b) the ability of these individuals to fabricate serum protein is impaired.

It has been demonstrated that even before operation the patients with gastrointestinal cancer have hypoproteinemia. From evidence recently presented (11) a decreased concentration of serum protein in most instances has been found to be associated with depletion of tissue proteins. When hypoproteinemia exists, only 3 per cent of ingested nitrogen is fabricated into plasma proteins and the remainder is used to replenish the tissue protein supply. Accordingly, the hypoproteinemia observed before operation in the patients with gastrointestinal cancer in part may be due to the fact that the protein stores of these individuals already are too small to maintain a constant serum protein level under the stress resulting from surgical manipulation and inevitable postoperative period of nitrogen fast.

The impaired ability of patients with gastrointestinal cancer to fabricate serum albumin (3) probably contributes to their significant degree of postoperative hypoproteinemia. A previous study of this series (2) strongly suggested that this impaired ability is due to an hepatic dysfunction which, like other hepatic functions (5), conceivably is further aggravated when the patients are subjected to surgery and manipulation of the liver.

SUMMARY

1. Patients with gastrointestinal cancer frequently develop after operation a negative nitrogen balance. The extent of this negative balance is no greater than that often developed after operation by patients with nonneoplastic disease of the gastrointestinal tract or with gynecologic disorders who undergo intra-abdominal operations.

2. Nevertheless, concentrations of protein in the serum of patients with gastrointestinal cancer fall after operation significantly more than do those of the patients with nonneoplastic gastrointestinal disorders or with gynecologic disease.

3. It is possible that the tissue protein stores of the patients with gastrointestinal cancer are considerably less than are those of the 2 control groups of patients studied.

REFERENCES

1. Ariel, I. M., Abels, J. C., Pack, G. T., and Rhoads, C. P. Metabolic studies in patients with cancer of the gastro-intestinal tract. XVI. The treatment of hypochloremia refractory to the administration of sodium chloride, especially in patients with gastrointestinal cancer. To be published.
2. Abels, J. C., Rekers, P. E., Binkley, G. E., Pack, G. T., and Rhoads, C. P. Ann. Int. M., 1942, 16: 221–240.
3. Ariel, I. M., Rekers, P. E., and Pack, G. T. Metabolic studies in patients with cancer of the gastrointestinal tract. X. Abnormalities of protein metabolism in patients with gastric cancer. To be published.
4. Barden, R. P., Ravdin, I. S., and Frazier, W. D. Am. J. Roentg., 1937, 38: 196–202.
5. Lord, J. W., Andrus, D. W., and Moore, R. A. Arch. Surg., 1940, 41: 585–595.
6. Madden, S. C., and Whipple, G. H. Physiol. Rev., 1940, 20: 194–217.
7. Maddock, W. G. Am. J. Surg., 1939, 46: 426–434.
8. Mecray, P. M., Jr., Barden, R. P., and Ravdin, I. S. Surgery, 1937, 1: 53–64.
9. Peters, J., and Van Slyke, D. D. Quantitative Clinical Chemistry. Vol. 1, p. 531. Baltimore: Williams & Wilkins, 1931.
10. Rhoads, J. E., Fliegelman, M. T., and Panzer, L. M. J. Am. M. Ass., 1942, 118: 21–25.
11. Sachar, L. A., Horvitz, A., and Elman, R. J. Exp. M., 1942, 75: 453–459.
12. Weech, A. A., Reeves, E. B., and Goettsch, E. J. Biol. Chem., 1936, 113: 167–174.

TREATMENT OF GASTRIC ULCER

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FOR many years the treatment of gastric ulcer has been the subject of considerable discussion and controversy. Some physicians have been enthusiastic regarding medical treatment whereas certain surgeons have been equally in favor of surgical treatment in the large majority of cases. It would seem that this subject should be pretty well settled after the extensive clinical experience which has been amassed in the management of this condition. However, confusion still persists regarding the ideal choice of therapy in many of these cases.

The important questions which must be answered before definite opinions can be reached include: (1) What is the percentage of error in the diagnosis of benign gastric ulcer when actually a small ulcerating carcinoma is present? (2) What is the percentage of cure of gastric ulcer treated medically? (3) What is the risk of operation for gastric ulcer? (4) What is the rate of ultimate cure of this lesion by surgical measures? Accurate answers to these questions should enable one to determine whether the risk of operation and chance of cure by surgical means are preferable to the chance of diagnostic error and likelihood of unsatisfactory results by medical measures. It is realized that generalizations often are misleading and unreliable for the individual patient, as obviously the choice of treatment must remain largely a matter to be decided for each individual patient; nevertheless it is helpful to know what the odds favor, so to speak. For this reason we have attempted to find answers to the questions listed.

ACCURACY OF CLINICAL DIAGNOSIS OF GASTRIC ULCER

As everyone realizes, an entirely accurate differential diagnosis cannot always be made between benign and malignant gastric ulcer. To concede this point one need not have any firm conviction regarding the pathogenic relationship between these two entirely distinct entities, and this subject will not be discussed at this time. It is sufficient to admit that certain small ulcerating carcinomas of the stomach may present a clinical picture which cannot be distinguished from that which may be found in association with benign ulcer. The main differential points between benign and malignant gastric ulceration such as age of the patient, duration and type of symptoms, size and location of the lesion, achlorhydria or hyperchlorhydria, roentgenologic and gastroscopic appearance, and response to medical treatment may in certain cases all be misleading. Thus, examples can be cited from personal experience wherein all factors, such as youthful age of the patient, long history of typically ulcer-like character, small lesion situated on the lesser curvature associated with high values for gastric acids, a roentgenologic and gastroscopic diagnosis of benign ulcer and a favorable immediate response to medical management, favored the diagnosis of benign ulcer, but notwithstanding the patient subsequently was found to have an actual carcinoma. Likewise the reverse may be true, whereby the results of clinical investigation all suggest the malignant nature of the lesion and a benign ulcer is demonstrated histologically. It is true that such occurrences are not common but in a small percentage of cases the majority of factors may favor one diagnosis and yet the diagnosis based on these findings may be erroneous. The tragedy of permitting a small, readily resectable, malignant lesion of the stomach to progress to the stage of inoperability or to the time when prognosis is much less favorable even though resection can be accomplished, because of postponement of operation by the initial medical treatment need not be emphasized.

A few reported observations on the difficulty of distinguishing between benign gastric

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ulcer and actual gastric carcinoma might be pertinent. For example, approximately 7 per cent of patients who undergo resection for malignant growths of the stomach are less than 40 years of age (4). Eighty per cent of patients who have gastric resection for malignant tumors and who previously received medical treatment for presumed benign ulcer experienced temporary relief from this form of therapy. Approximately 1 of 5 patients who has gastric resection performed for cancer has normal or elevated values for gastric acids. Although 9 out of 10 benign gastric ulcers which are removed surgically are smaller than a quarter, it has been noted that approximately one-fifth of the carcinomatous lesions removed from the stomach have an area of ulceration 4 centimeters or less in diameter (2). Over a period of many years the diagnosis of gastric ulcer has been made by the roentgenologist in approximately 10 per cent of cases in which resection has been performed for actual carcinoma (4).

Thus it is emphasized again that there is no single clinical criterion which can make an accurate differential diagnosis between benign and malignant gastric ulcer. The only method of certain differentiation is prolonged observation under medical treatment. Such observation we believe should be carried on (intermittently following the first several months) for a period of at least several years. If the lesion disappears promptly and remains absent roentgenologically and gastroscopically for this period of time, one would feel fairly confident that it is benign in nature. Of course, should it prove to be malignant during this interval, the optimal time for surgical treatment, namely, when the lesion was in an early stage of development, would have been lost.

What then, in answer to the first question proposed, is the actual error of diagnosis in benign ulcer? This may be approached in two ways, first the percentage of error found in cases in which patients are treated surgically and, second, the percentage of error found in cases in which patients are treated medically. A recent review revealed that carcinoma was found on exploration in 19, or 8 per cent, of 237 cases in which a diagnosis of benign gastric ulcer was made and operation was performed at the Mayo Clinic during 1939 and 1940. As a corollary, in a series of 559 cases in which operation was performed for gastric carcinoma during this same period, the diagnosis in the 19 cases mentioned here was gastric ulcer. In order to determine the results of the medical treatment of gastric ulcer, of which more will be said later, 146 patients whose condition was diagnosed as benign gastric ulcer between the years 1930 and 1937 and who were treated medically were traced to the present time. Of this group it is known that 14 patients, or 9.6 per cent, subsequently were shown to have gastric carcinoma. This observation is supported by the findings of others, including Allen and Welch, who reported 277 cases in which the diagnosis of benign gastric ulcer was made. Thirty-nine, or 14 per cent, of these patients later were known to have carcinoma. Some were treated medically and others surgically. Of the 175 patients in this group who were treated medically, 13, or somewhat more than 7 per cent, subsequently were found to have carcinoma. Considering the chance of diagnostic error based on clinical criteria from these various points of view it is evident that approximately once in 10 or 12 times the clinical diagnosis of benign gastric ulcer will be in error, and in truth carcinoma will be present.

RESULTS OF MEDICAL TREATMENT OF GASTRIC ULCER

A recent study has been made concerning the second question, namely, what are the results of medical treatment of benign gastric ulcer? Cases in which the diagnosis of gastric ulcer was made in the Mayo Clinic during the years 1930 to 1937, as previously mentioned, have been reviewed. More recent cases were not included in the study in order to have a follow-up period of at least 5 years. There were 146 cases in this group which filled the necessary requirements for the study; namely, a complete examination was performed, the diagnosis of gastric ulcer was made, medical treatment was instituted, and knowledge of the present condition of the patient was obtained. There were numerous other cases, similar to these, which were not included because of some slight suspicion of cancer, the

fact that operation had been advised but not performed, and because information regarding the condition of the patient could not be obtained at this time. Of these 146 patients 68 were admitted to the clinic on one occasion only. In some instances this original admission constituted a prolonged period of observation, and in other cases it did not. Although, following their departure, fairly close contact was maintained with these patients through the physician at home and by other means, it might be said that this does not constitute adequate and proper treatment of the patient who has gastric ulcer. Therefore, this group of 68 patients was separated from the remaining group of 78 which was followed closely on repeated visits by roentgenologic or gastroscopic examination for an average of 2.9 years. In addition recent information regarding both groups of patients has been obtained by letter in most cases at an interval which varied from 5 to 12 years following the original admission. It was noted that the results were virtually the same in both groups of patients and for that reason the results obtained in the entire group will be considered. At first it might appear surprising that results were not definitely more favorable in the group which was kept under prolonged observation. On reflection, however, it is apparent that no amount of treatment could be accepted to influence the incidence of carcinoma in either group and most patients can follow the proper therapeutic medical regimen just as well following adequate instruction on an initial visit as after repeated visits, provided of course that adequate instruction is given the first time.

Of the 146 cases in which the diagnosis of benign gastric ulcer was made, medical treatment instituted, and the patient's progress during a period of 5 to 12 years ascertained, cure occurred in only 46.5 per cent (Table I). An additional 15.8 per cent of the patients had no symptoms if the medical regimen was followed constantly; 4.8 per cent were found to have gastric ulcer by roentgenologic diagnosis; 11 per cent were operated on because of failure of medical management and found to have gastric ulcer and 9.6 per cent (14 patients) presented definite evidence of gastric carcinoma. Of this group of 14 patients one-half

TABLE I.—RESULTS OF MEDICAL TREATMENT OF GASTRIC ULCER

Type of Result	Cases	Per cent
Cure	68	46.5
Symptoms absent if medical regimen is followed	23	15.8
Gastric ulcer present roentgenologically	7	4.8
Operation for gastric ulcer	16	11.0
Definite evidence of carcinoma developed	14	9.6
Death from hemorrhage	1	0.7
Deaths from unrelated causes	17	11.6
Total	146	100

(7 patients) died of metastatic carcinoma and the remainder were explored surgically; however, in only 3 cases could the gastric cancer be removed. Eleven and six-tenths per cent of the entire group of 146 patients died of apparently unrelated causes and 0.7 per cent (1 patient) died of gastric hemorrhage.

Analysis of these results indicates that the medical treatment of presumed benign gastric ulcer leaves considerable to be desired. With cure accomplished in somewhat less than 50 per cent of cases and with approximately 10 per cent of patients subsequently manifesting frank carcinoma of the stomach, one could hardly call the results eminently satisfactory. In addition, 11 per cent of the patients required operation subsequently for benign gastric ulcer because of failure of medical management. One need operate on only a few penetrating gastric ulcers which have eroded completely through the wall of the stomach and have a crater, the base of which is formed perhaps by the pancreas, to appreciate the difficulties inherent in effecting complete healing of the lesion by medical measures. In addition, the marked degree of gastritis and inflammatory activity of a benign gastric ulcer so often seen at the operating table following intensive medical treatment for several weeks in the hospital prior to operation serve to emphasize the ineffectiveness of medical management in many of these cases.

RISK OF SURGICAL TREATMENT OF GASTRIC ULCER

In contrast with results obtained by the medical treatment of gastric ulcer, what may be expected from the surgical treatment of these patients? The first question to consider

in this regard is the risk of operation. This, of course, will vary with the condition of the patient, experience of the surgeon, type of operation performed, and preoperative and postoperative care. It is obvious that no definite figure can ever be established in this connection which will be universally applicable for all patients and all surgeons. About all that can be determined in this regard is for an individual surgeon or group of surgeons to record personal experience in cases of this type. During the past 5 years at the Mayo Clinic the risk of gastric resection performed for gastric ulcer in 400 cases has been 2.5 per cent. During this same time the risk of local excision and gastroenterostomy for gastric ulcer has been 3.3 per cent. These mortality figures include all patients who died in the hospital following operation.

ULTIMATE RESULTS OF SURGICAL TREATMENT

What then may one anticipate regarding ultimate cure of those patients who have gastric resection performed for benign gastric ulcer and survive the operation? In our experience resection of the stomach for gastric ulcer is followed by some of the most satisfactory results that are obtained in the surgical treatment of any gastric or duodenal lesions. Walters and Clagett (3) in 1940 reported on 272 cases of gastric ulcer treated surgically. Follow-up studies over a period of 1 to 5 years were obtained in 162 cases. There was no known incidence of the development of gastrojejunal ulcer, and only one patient in the entire group classified his result as entirely unsatisfactory. Of 29 patients followed on whom local excision combined with gastroenterostomy was performed, 27 had an entirely satisfactory result and 2 had mild distress at times. Of 85 patients on whom a Pólya type of resection was carried out, 80 had an entirely satisfactory result and 5 were in good health but had occasional slight distress. Information in some of these cases was obtained by questionnaire which may be considered unreliable; however, it is seldom that a patient will write that he is well unless he actually feels well. The length of follow-up period may be a little short for an accurate analysis of the true ultimate results, and yet it coincides quite closely with our experience. Other procedures, such as local excision alone, sleeve resection or gastroenterostomy alone, are followed by somewhat less satisfactory results.

CHOICE OF OPERATION FOR GASTRIC ULCER

In former years local excision of a gastric ulcer combined with gastroenterostomy was considered to be the treatment of choice in many cases. At the present time we seldom employ this form of treatment for several reasons. In the first place if local excision of the ulcer is performed, in a certain number of cases, the pathologist may subsequently report that the lesion actually is malignant, in which case an entirely inadequate removal of the involved tissue has been performed and further operation is advisable in most cases. In addition, it has been found during recent years that gastric resection can be performed for gastric ulcer with virtually the same mortality rate associated with local excision and gastroenterostomy. Formerly it was thought that certain gastric ulcers were inaccessible for resection, but we know now that virtually every gastric ulcer can be removed by resection with utilization of various modifications of the Pólya type of operation, notably the Hofmeister type. By way of digression it might be mentioned that the presumed inaccessability of certain gastric ulcers formerly was used as an argument in favor of medical management of certain high-lying lesions. This argument is no longer valid. Gastroenterostomy alone does not constitute adequate treatment for the patient with gastric ulcer as in 8 of the 146 cases of gastric ulcer previously mentioned, this operation had been performed previously (in 6 cases for duodenal ulcer and in 2 cases for gastric ulcer).

The surgical treatment of choice in most cases of gastric ulcer, we think, is gastric resection. For the lesion situated in the distal third of the stomach, a Billroth I type of operation can be employed with satisfaction in some cases. In general the posterior Pólya operation is the one which we employ most frequently. When dealing with an ulcer situated high on the lesser curvature of the stomach, the Hofmeister modification of the

posterior Pólya operation often is most satisfactory. Occasionally if the lesion is especially high, an anterior type of anastomosis without enteroanastomosis is employed. This type of operation, however, is used only infrequently. Modifications of this procedure may be employed for an ulcer situated in the cardia on the anterior or posterior walls of the stomach.

OBSERVATION

On the basis of our experience we are inclined to favor the surgical treatment of gastric ulcer in an increasing number of cases. Thus, the preoperative diagnostic error in cases of gastric ulcer of approximately 10 per cent and the late results of medical treatment with somewhat less than half of the patients being completely relieved does not make a very good record for medical treatment. In contrast the low operative risk of gastric ulcer (2.5 per cent for resection) and the satisfactory end-results in the large majority of cases certainly favor surgical treatment in these cases. This is especially true when dealing with the perforating lesions which we believe are always surgical if the patient's general condition permits. We do not mean to imply that all cases of simple, superficial gastric ulceration, perhaps associated with an exacerbation of gastritis should be treated surgically. Lesions of this type generally respond readily to medical management and do not carry the threat of unrecognized malignancy. It is realized that conclusions based on a statistical study of this type may be misleading. On the other hand, observations of the various cases reported form the basis on which one may logically establish clinical judgments. It is our opinion that the choice of treatment for the patient with gastric ulcer really does not lie between medical and surgical but rather between immediate surgical treatment and a trial of medical management under close observation followed by surgical treatment if prompt and permanent healing of the ulcer does not occur. By adhering to this type of medical management the unfortunate development of a large and inoperable carcinoma prior to its recognition may be obviated in most cases. In reaching the decision regarding the choice of medical or surgical treatment in a given case, it is well to keep in mind the relative risk of each form of treatment as well as the chance of cure which either medical or surgical treatment may afford.

SUMMARY

1. The error in the preoperative diagnosis of gastric ulcer in differentiation from gastric cancer is approximately 10 per cent.

2. Only approximately half of the patients who are treated medically for gastric ulcer have a result which they consider entirely satisfactory.

3. Approximately 10 per cent of patients treated medically for gastric ulcer subsequently prove to have carcinoma.

4. The risk of gastric resection for gastric ulcer in our experience is 2.5 per cent.

5. The results of the surgical treatment of gastric ulcer are entirely satisfactory in the majority of cases.

REFERENCES

1. Allen, A. W., and Welch, C. E. Ann. Surg., 1941, 114: 498–509.
2. Alvarez, W. C., and McCarty, W. C. J. Am. M. Ass., 1928, 91: 226–231.
3. Walters, Waltman, and Clagett, O. T. Surg. Gyn. Obst., 1940, 71: 75–79.
4. Walters, Waltman, Gray, H. K., and Priestley, J. T. J. Am. M. Ass., 1941, 117: 1675–1681.

RUPTURE OF THE UTERUS

An Analysis of 30 Maternal Deaths

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RUPTURE of the uterus is commonly stated to be a grave complication of pregnancy and labor, yet it is generally thought to occur infrequently, and its importance as a considerable increment of our puerperal mortality is not generally appreciated. The frequency of its occurrence is actually unknown, figures on its incidence varying widely from 1 in 95 (13) deliveries to 1 in 6000. A growing appreciation of the great importance of the rôle of hemorrhage in maternal deaths, and reports of several large series of rupture of the uterus (1, 3–6, 13) during the last 5 years show increasing interest.

In any area the frequency of traumatic rupture, at least, will depend upon the quality of obstetric care. In hospital practice its incidence will vary with chance factors. Old figures are largely voided by the increasing frequency of cesarean section. Lynch has reported 33 cases during a 20 year period at the Boston City Hospital, and Sheldon found the same number of cases at the Boston Lying-In Hospital from 1916 to 1938, an incidence of 1 in every 1,105 deliveries. Reese and Linn, reporting 34 cases from the records of the University and Baltimore City Hospitals, found an incidence of 1 in 1,516 cases. Dugger, for the Committee on Maternal Welfare of the Philadelphia County Medical Society, analyzed 105 cases, all the cases known to have occurred in Philadelphia during the 10 year period 1931 to 1941, an incidence of 1 in every 3,029 births. There were 65 deaths in this series, a mortality of 62 per cent, which contributed 6.6 per cent to the puerperal mortality rate, if ectopic pregnancy and abortion were excluded. Bingham reporting on maternal mortality for 1940 in the State of New Jersey says "that rupture of the uterus was a frequent cause of death, one-half of these cases resulting from version." Titus found 7 cases diagnosed as rupture of the uterus in 276 cases of puerperal death in Massachusetts in 1938, yet he felt sure that in other cases in which death was attributed to shock, rupture of the uterus was the actual cause. In Rhode Island (12), in 1940, there were but 25 puerperal deaths, yet in 3 cases, or 12 per cent, of that state's enviably low mortality rate, death was due to rupture of the uterus.

Siegel (7), analyzing the puerperal mortality of the City of Buffalo for 1935–1940, reported 18 deaths due to uterine rupture, accounting for 6 per cent of the total number of 313 puerperal deaths, or 8 per cent of deaths when ectopic pregnancy and abortion are excluded. Nearly one-half of these deaths occurred during version and extraction. It appears, however, that there were 32 deaths in Buffalo due to version; in 21 of these death occurred on the first day, yet only 7 were known to have a ruptured uterus. The opinion of the Maternal Mortality Committee in Buffalo (8) was that the number of deaths attributed to this cause would have been very much higher if more cases had come to autopsy.

When the Children's Bureau (10) in 1927–1928 studied 7,380 maternal deaths in 15 states, but 91 cases were found in which rupture of the uterus was diagnosed by the attending physician or at autopsy. However, the obstetric advisory committee believed that the history clearly pointed to rupture in 68 cases, and made such a diagnosis probable in 109 other cases, a total of 268 cases. These deaths accounted for 3.3 per cent of the total rate, or 5.4 per cent if ectopic gestation and abortion were excluded. The proportion of maternal deaths that were associated with ectopic gestation, as either primary or secondary, was 4 per cent, varying from 1 to 7 per cent in the several states.

In 1940, in the entire United States (11), ectopic gestation accounted for 4.4 per cent of the total number of puerperal deaths, or 5.5 per cent exclusive of abortion. It is probable that rupture of the uterus is an even more important cause of maternal death, for 23 per cent (2,058) of all the puerperal deaths (8,876) were caused by hemorrhage, trauma, and shock, yet placenta previa and separation of the normally implanted placenta accounted for only hardly more than one-fifth of them (448).

In Brooklyn, City of New York, the Committee on Maternal Welfare of the Medical Society of the County of Kings, after study of 660 puerperal deaths recorded during the period January, 1937, to September, 1942, found that at least 30 women died from rupture of the uterus, or 5.4 per cent of the total, if deaths due to ectopic gestation and abortion were excluded. During this same period, ectopic gestation accounted for 5.7 per cent of the deaths, excluding abortions.

It seems clear, then, that in many communities rupture of the uterus exceeds, or at least equals, ectopic pregnancy as a cause for maternal mortality. The comparison may be carried further, for, like ectopic pregnancy, rupture of the uterus must be thought of in a given case if the diagnosis is to be made more frequently. In our own experience failure to consider rupture of the uterus as a cause for such single or combined symptoms as loss of the fetal heart, cessation of contractions, and shock during labor; or shock after operative vaginal delivery when external hemorrhage has been insufficient to account for it, has often resulted in failure of diagnosis and death.

In 11 of these cases of death from rupture of the uterus the diagnosis was not made by the physician until autopsy findings were reported. The committee believes that the actual number of deaths was larger than the number reported, for there were other cases in which the diagnosis was probable and have not been included in these figures.

It is not possible to state the true incidence of rupture of the uterus in Brooklyn since the files of the committee contain information only on those in whom operation or autopsy showed death from this cause. Fairly good abstracts of 30 such case records are available. In every case the diagnosis was proved by operation or autopsy or exploration of the uterus. Not all the data we should like to have can be found in these records, and the description of symptoms and signs associated with rupture was often meager, yet information as to the time of diagnosis and the nature of treatment was definite in every case.

CLINICAL DATA

Age, color, and parity. In 15, or half the patients, rupture took place between the ages of 35 and 45 years. There were 5 patients in the age group 20 to 30 years, 10 patients in the 30 to 35 years group, 11 patients were between the age limits of 35 to 40 years, and 4 patients between the ages of 40 to 45 years. In 2 cases color was not recorded; 23 were white and 5 colored. There were only 3 primiparae and they were in the age group 20 to 35 years.

Duration of labor. In only 2 cases did rupture occur before the onset of labor. In one of these, a primipara, rupture of a myomectomy scar occurred in the seventh month of pregnancy. At operation, 1 hour later, a living fetus was extracted by enlarging the tear in the uterus, which was then sutured. She vomited repeatedly during the one-half hour required for induction of ether anesthesia, and died of bronchopneumonia. The other patient was a young colored multipara in the sixth month of pregnancy who died of peritonitis following operation at which a rent was found in the lower segment of the uterus anteriorly. The cause of rupture was unknown, though it was possibly due to instrumental perforation.

The duration of labor in the other 28 cases is shown in Table I.

TABLE I.—HOURS IN LABOR

No. of hours	Spontaneous	Traumatic	Total
Less than 6	4	1	5
6 to 12	7	2	9
12 to 24	1	3	4
24 to 36		3	3
More than 36		*5	5
Unstated		2	2
	12	16	28

*All patients in the table were multiparae except 2 in this group.

Etiology. Spontaneous rupture occurred in 13 cases. All but 2 took place during labor. In

TABLE II.—SPONTANEOUS RUPTURE

No. Age Parity	Hrs. in labor	Stage of labor	Site of rupture		Causal factors
			Lower	Upper	
1 37 3	6	2	X		Fibroids, obesity, pendulous abdomen
2 40 14	16	1	X		Obesity, pendulous abdomen
3 36 5	9	1	X		Hydrocephalus
4 39 1	5	1	X		Previa, many induced abortions
5 36 1	5	1		X	Previous section
6 35 3	11	1	X	X	Cauterization of cervix
7 37 3	20	1	X	X	Cervical scar
8 33 1	5	2	X		Cervical scar

3 cases no cause could be assigned, and in the other 8 cases, the causes were varied (Table II).

Cases 6, 7, and 8 in Table II are of special interest. In all there were probably extensive cervical scarring. In Case 6 there had been done a previous cauterization of the cervix. In Case 7 the previous history included a difficult forceps delivery with cervical laceration and at operation the tear in the lower uterine segment was directly continuous with a complete lateral tear in the cervix. Case 8 was similar in that the previous history included a version and extraction through an incompletely dilated cervix and we can assume the occurrence of laceration and subsequent scarring. These 3 cases clearly show the rôle of cervical scarring in the etiology of spontaneous rupture. It may also explain certain cases of spontaneous rupture in apparently normal uteri in the "*grande multipara*" during labor. Previous theories have referred principally to myometrial pathology rather than to extension of cervical laceration into the lower uterine segment.

Traumatic. In this group were 17 patients, rupture in 1 case occurring during pregnancy. Pituitrin was the cause in 1 case. It may have been administered in other cases, but, if so, it was not reported. In the remaining 15 cases version accounted for 7, in 3 of which forceps had failed. Four were due to forceps, 2 followed mutilating operations, 1 the Pinard maneuver, and 1 was due to strong and prolonged fundal pressure.

TABLE III.—TRAUMATIC RUPTURE OF THE UTERUS–VERSION

Age	Parity	Hours in labor	Stage	Previous procedure	Complication
31*	8	—	1		Placenta previa
38	1	7	1		Transverse
32*	1	30	2	Incisions in cervix	Transverse
37*	3	34	2	Failed forceps	
32	0	51	2	Failed forceps	Disproportion
26*	0	52	2	Failed forceps	Disproportion
28	1	58	2	Manual rotation	Disproportion

*Version followed by extraction.

Internal version was the principal cause of traumatic rupture. Table III shows that in 5 of the cases version was performed after 30 to 58 hours of labor, a definite contraindication to this procedure because of marked thinning out of the lower uterine segment. Other hazardous procedures, such as prompt extraction following version for placenta previa, were also reported.

Signs and symptoms. In the 2 cases of spontaneous rupture which occurred before labor began, severe abdominal pain followed, without bleeding or shock. In the other 11 cases of spontaneous rupture, shock was notable, occurring in 9 cases. Vaginal bleeding was profuse in 2 cases, slight in 7 cases, not mentioned in 1 case, and in 1 case there was none at all. Abdominal pain was severe in but 5 cases. In 6 cases labor ceased. In only 3 cases were fetal parts recorded as easily felt beneath the abdominal wall.

The clinical picture of traumatic rupture was one of shock, with or without increased vaginal bleeding. In 11 cases shock was profound and hemorrhage was profuse in 6 cases.

Site of rupture. In 26 cases rupture was complete, and in 4 incomplete. Except in 2 cases in which rupture followed myomectomy and previous cesarean section, the lower segment was involved in every case. In 4 cases involving both upper and lower segments, 1 was due to previous suspension of the uterus for retroversion and cauterization of the cervix; 1 was caused by pituitrin; 1 was of

unknown origin occurring in a multipara, aged 38 years, after 8 hours of labor; and one began at an old cervical scar and extended superiorly.

In 6 cases of rupture in the lower segment, its exact location was not stated. Lateral longitudinal rupture right or left, was the common lesion, with 15 cases in this group. Hematoma of the broad ligament was frequently observed. Transverse rupture of the anterior lower segment was next in frequency, a total of 6 cases, with 2 cases of spontaneous rupture during labor occurring in this group. Posterior rupture of the lower segment was noted in 3 cases; in 2 of these cases forceps had failed of delivery, and in the other, 2 semilunar transverse tears resulted from the Scanzoni maneuver.

Diagnosis. The diagnosis was made before death in 19 cases, yet in 7 cases more than 2 hours had elapsed, and in 1 case not until 7 days after rupture had occurred was the diagnosis made. In 11 cases the diagnosis was made only at autopsy. Thus in only 12, or 40 per cent of the cases, was the diagnosis made within a time interval in which there is reasonable opportunity for successful treatment.

In the spontaneous rupture group, the diagnosis was not made in only 3 cases. In 1 case, because of precordial pain and dyspnea, shock was thought to be due to coronary thrombosis; in another, rupture of a cesarean section scar was mistaken for ablatio placentae; and the third case occurred in a quattuordecipara, 40 years of age.

In rupture due to trauma, however, the diagnosis was correct in but 9 of the 17 cases. Hemorrhage and shock were commonly attributed to the operative procedure, not to rupture of the uterus. The lapse of time before diagnosis was made is shown in Table IV.

Treatment and causes of death. In 13 cases operation was not performed, principally because of failure of diagnosis, for in 11 cases, it will be recalled, the diagnosis was first made at autopsy. Eleven of these women died of hemorrhage and shock within a few hours, while 2 died of peritonitis.

Supravaginal hysterectomy was performed in 16 cases, and in 1 case the laceration was sutured. In 9 cases hemorrhage and shock caused death shortly after operation; in 4 cases death was due to peritonitis, and in 3 cases to bronchopneumonia.

TABLE IV.—TIME INTERVAL IN DIAGNOSIS

Type of Rupture	Within 2 hours	More than 2 hours	Not until autopsy
Spontaneous	7	3	3
Traumatic	5	4	8
Total	12	7	11

In the entire number of 30 cases death was due to hemorrhage and shock in 20 cases, peritonitis in 6 cases, bronchopneumonia in 3 cases, and anuria in 1 case.

Of the 30 babies 3 survived, a fetal mortality of 90 per cent. Two women died who were undelivered.

Adequate transfusions of blood were administered in but 3 cases; 11 women received moderate amounts of blood, 5 received totally inadequate amounts, and 11 were given no blood at all. Undue confidence was had in crystalloid solutions, and many varieties of cardiac stimulants were administered. Blood plasma or serum were not used in any case, yet it is admitted that the large majority of these deaths took place before the value of these blood substitutes had been well recognized.

SUMMARY

The importance of rupture of the uterus as a factor contributing at least 6 per cent to the maternal death rate is shown. It probably is a more common cause of death than ectopic gestation. There is very little doubt that rates are higher than commonly reported, for failure of diagnosis is common.

In an analysis of 30 puerperal deaths occurring in Brooklyn during a 6 year period, the rôle of age and multiparity is shown and the causes of rupture and the data associated with delivery are indicated. Rupture was spontaneous in 13 cases. In the group of 17 traumatic cases, 7 were due to version in the face of well accepted contraindications.

With the exception of 2 cases in which rupture occurred at the site of a previous cesarean section or myomectomy scar, it was the lower segment which was involved in every case.

The diagnosis was late in the majority of cases, being made within 2 hours in only 12 or 40 per cent of the cases. In 11 cases the diagnosis was first made at autopsy.

In the traumatic group hemorrhage and shock were commonly attributed to the operative procedure, and not to rupture of the uterus. In 3 cases in which the uterus was explored, the rent in the uterine wall was not discovered.

Inadequate blood transfusions, or none at all, were administered to the majority of patients. Other intravenous therapy and various cardio-respiratory stimulants were relied upon for treatment of shock.

REFERENCES

1. Beacham, W. D., and Varino, G. A. Clinics, 1942, 1: 125.
2. Bingham, A. W. J. M. Soc. N. Jersey, 1942, 39: 33.
3. Dugger, J. H. Pennsylvania M. J., 1942. 45: 437.
4. Lynch, F. J. N. England J. M., 1939. 221: 847.
5. Reese, J. M., and Linn, R. F. West Virginia M. J., 1941, 37: 402.
6. Sheldon, C. P. Discussion of paper by Lynch. Loc. cit.
7. Siegel, L. A. N. York State J. M., 1942, 42: 1472.
8. Idem. Personal communication, Dec. 9, 1942.
9. Titus, R. S. N. England J. M., 1939, 221: 845.
10. U. S. Department of Labor, Children's Bureau Publication No. 223.
11. Yerushalmy, J. Child, 1942, 6: 195.
12. Walsh, J. G. Rhode Island M. J., 1941, 24: 130.
13. Whitacre, F. E., and Fang, L. Y. Arch. Surg., 1942 45: 213.
14. White, R. E. J. M. Soc. N. Jersey, 1942, 39: 446.

HEPARIN TOLERANCE

A Test of the Clotting Mechanism

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DURING the use of heparin in surgical patients one encounters a great variability of response in different individuals or even in the same individual under different circumstances. Thus some patients seem to react promptly and intensely, whereas, others require a great deal of heparin to obtain a sufficient prolongation of the clotting time. It would take several days to readjust the dosage to the patient's requirements and much important time would be lost whether the continuous or the intermittent type of intravenous administration were used. Also hematomas or severe hemorrhages were encountered after operation in patients who had received the customary, moderate doses of heparin.

Later, it became obvious that even the same patient would show a variable response under different circumstances. A simple test for heparin sensitivity was devised; simple enough so that it could be run in any hospital or home, whenever the administration of heparin seemed advisable. For the experimental and clinical studies on heparin, one can refer to the work of Best, Murray and his coworkers (11) and those of Crafoord and Jorpes. Monographs and reviews have recently summarized the previous literature (4, 7, 9).

In this communication I wish to report my preliminary observations made with 328 tests on 114 patients. The test provides an interesting insight into factors influencing the clotting mechanism and thus opens an avenue for further investigation.

THE METHOD

Ten milligrams (1 c.c.) of purified heparin are injected intravenously. A hypodermic syringe and needle are used for the purpose. Coagulation time is determined before and 10, 20, 30, and 40 minutes after the injection. The capillary tube is used for the determination of coagulation time. The finger tip is punctured with a standard automatic lance. The first drop of blood is gently wiped off and the second drop is taken up by the capillary tube. The tubes are drawn out to a length of 15 to 20 centimeters (5 to 8 inches); their diameter is 1 millimeter. They should be chemically clean and dry. During the test the tube is held in the palm of the hand, thus providing thermostatic control. The tube is broken every 30 seconds (or more often if desired), and the appearance of the first thread of fibrin is taken as an end-point, measured from the time the second drop of blood appeared.

This method can be taught to and used by student nurses, and occasionally by patients who administer oral anticoagulants to themselves. The percentage of errors occurring from the mixture of the blood with tissue juice is small. The method is not such an accurate estimate of the pure coagulation time as the Lee and White procedure, which is preferred by most research workers. However, the determination of venous blood *in vitro*, as practiced by Lee and White, fails to measure two important factors in spontaneous hemostasis, namely, the admixture of thromboplastin at the time of injury and the capillary contractility. The former is included in the capillary method, the latter is measured, if desired, by the equally simple bleeding time.

A normal response was plotted from an average of 50 curves (Fig. 1). Arbitrarily, if the coagulation time did not rise above 4½ minutes at 10 minutes after the injection, the patient was labeled as having a subnormal or delayed response. In some cases the curve remained absolutely flat, the coagulation time having been entirely uninfluenced by the small amount of heparin. On the other hand, hyper-

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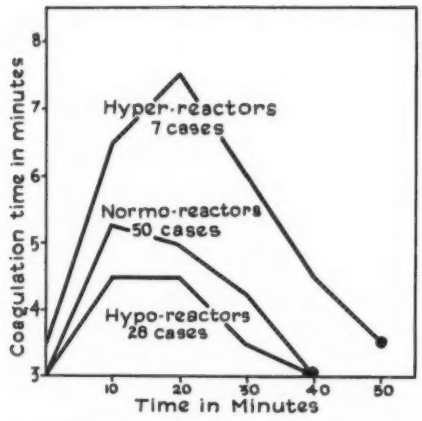

Fig. 1. The response of the first 85 patients after the intravenous administration of 10 milligrams of heparin. Arbitrarily they were labeled as hyporeactors, if the coagulation time did not rise above 4½ minutes after the injection of heparin. The term hyperreactor was used for patients whose coagulation time rose to or above 7½ minutes after the injection of heparin.

reactors were also encountered, showing phenomena of sensitization, such as flushing of the face, difficulty in breathing, sweating and faintness. In this group 8 such cases were encountered, but I have seen several such reactions before this study was undertaken. The heparin curves in the same individual are remarkably constant. They were determined for 17 consecutive days without notable change (Table I).

TABLE I.—DAILY HEPARIN CURVES FOR 17 DAYS

Date		Before heparin	After heparin			
		Minutes	Minutes			
			10	20	30	40
August	24	3.5	6.5	4.5	3.5	3.5
	25	3.5	7	4.5	3.5	3.5
	26	3.5	6	5	3.5	3.5
	27	3.5	6.5	5	3.5	3.5
	28	3.5	6	4.5	3.5	3.5
	29	3.5	6.5	5	3.5	3.5
	30	3.5	6.5	4.5	3.5	3.5
	31	3	6	4.5	3.5	3.5
September	1	3.5	6.5	4.5	3.5	3.5
	2	3.5	6.5	5	4.5	3.5
	3	3	5	3	3	3
	4	3.5	6	4.5	3.5	3.5
	5	3.5	6	4.5	3.5	3.5
	6	3.5	6	5	3.5	3.5
	7	3.5	6	5	3.5	3.5
	8	3.5	6	4	3.5	3.5
	9	3.5	7	5	3.5	3.5

Oval L., 19 years old. Comminuted fracture of right lower leg and thigh suffered 3 weeks previous to tests.

THE HYPOREACTOR GROUP

Of the 87 patients studied, 36 were placed in the group of hyporeactors, some of them only temporarily. The comparatively high incidence of patients with poor response to heparin is explained by our interest in just such a group. They were subdivided into patients in the postoperative state, patients with cardiovascular accidents and patients suffering from Buerger's disease.

A. The postoperative state. If one uses the diagram of Schmidt-Fuld-Moravitz for the explanation of the clotting mechanism, one would expect an increased need for heparin in the early days following operation, when thrombokinase is liberated from the tissues and when platelets disintegrate (Fig. 2). Elsewhere (5) I have summarized the changes in the blood reported after operations. There is an initial fall and secondary rise in platelets, an increase in fibrinogen, a shift or reversal of the albumin-globulin ratio in favor of the globulins and an increase in blood viscosity. All of these factors favor the agglutination of platelets, which normally possess a marked negative potential and tend to repel each other.

The coagulation of the blood is favored by the postoperative leucocytosis and the disintegration of platelets, both of which liberate thrombokinase. Dehydration and loss of plasma occurring in burns, shock, and intestinal obstruction also shorten coagulation time.

Thus, the agglutination of platelets seems largely responsible for the initial thrombus, whereas, the increased coagulability of the blood hastens the superimposed, spreading red thrombi in the stagnating or retarded blood stream surrounding the agglutination-thrombus. In the postoperative state, then, a

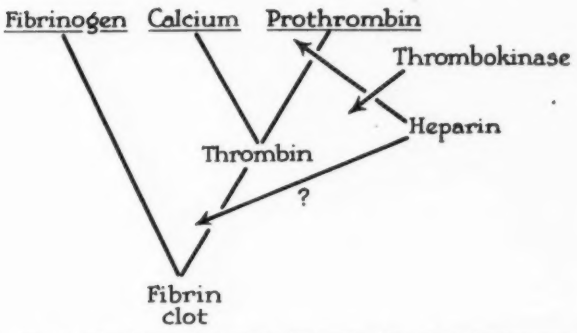

Fig. 2. The theory of clotting (Howell). The three fundamental factors, fibrinogen, calcium and prothrombin are underlined. In the case of injury to tissues or after disintegration of platelets, thrombokinase (cephalin) is released and counteracts heparin so that prothrombin is free to join with calcium to form thrombin, which in turn unites with fibrinogen to form fibrin.

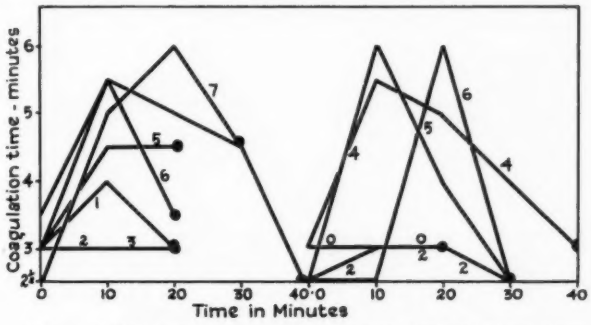

Fig. 3. Serial heparin curves of 2 patients, both of whom show marked heparin resistance after operation. In the case of H. W. (ruptured appendix, diffuse peritonitis), the curves, at left, are completely flat on the 2d and 3d days, whereas in the case of M. H. (congenital hypoplastic kidney, hypertension; nephrectomy), at right, the curve is absolutely flat on the day of operation and very flat on the 2d day. After the 4th day, both patients exhibited a normal response. Figures on curves indicate day after operation.

combination of increased agglutination of platelets and an accelerated coagulability are at work.

Recently Shapiro, Sherwin, and Gordimer confirmed the initial fall and subsequent rise of platelets following operations and also the initial decrease and secondary increase in prothrombin levels. In 14 out of 23 surgical cases, the prothrombin level was found to increase usually concomitantly with the thrombocytosis occurring on the 6th to 10th day following operation.

The heparin curves determined daily after operations show a marked flattening, sometimes a complete resistance to heparin. This phase usually ends on the 4th day; corresponding to the increase in platelets, there is an increase in prothrombin activity (14). Two such serial determinations are shown in Figure 3. In the case of H. W. the response to heparin was diminished on the 1st day after operation, completely absent on the 2d and 3d days, improved on the 5th, normal on the 6th and 7th days. In the case of M. H. the response to heparin was absent on the day of operation, very slight on the 2d day and normal after the 4th day. If the patients are hyperreactors to start with, the decreased

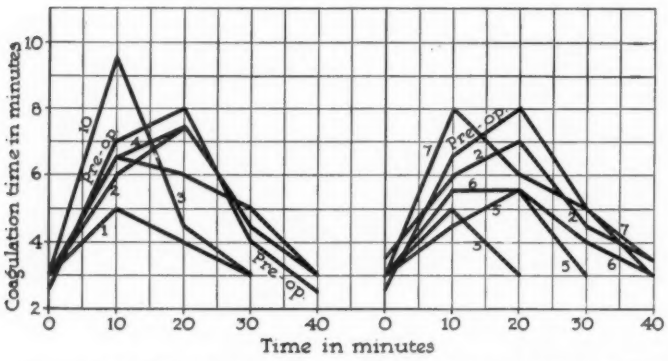

Fig. 4. Both of these patients were hyperreactors before operation. As a result, their postoperative resistance is not as marked as that shown in the previous graph. Nevertheless, on the 1st and 3d days, respectively, the response to heparin is diminished. At left, H. F., hypertension, sympathectomy. At right, M. S., uterine fibroids, abdominal hysterectomy.

response to heparin is not as marked and only very temporary (Fig. 4). It is still evident, however, on the 1st postoperative day of H. F. and the 3d and 5th days of M. S. Conversely, in the case of H. Z., who consistently showed a diminished reaction to heparin, the postoperative period was characterized by a complete lack of reactivity on the 2d and 6th days; the only fair response on the 8th and 9th days. The last curve obtained on the 12th postoperative day, with a peak of 4½ minutes at 10 minutes, places this patient in the hyporeactor group (Fig. 5). Minor surgical operations, however, do not influence the heparin curve (Fig. 7).

B. Cardiovascular accidents. Patients with coronary thrombosis, cerebral thrombosis, arterial embolism, and venous thrombosis, exclusive of Buerger's disease, have been grouped under this heading. Eighteen patients are available for study, all showing flat curves. Only patients whose vascular occlusion occurred within a few days of the determination of their heparin sensitivity are included. As a control, we have a group of 9 patients with identical vascular involvement, but in whom the thrombotic episode had occurred weeks or months previous to the study of their response to heparin. These curves fall within normal limits. A few of the illustrative curves are charted in Figure 6.

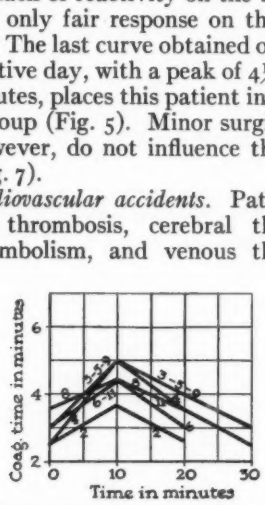

Fig. 5. This patient belongs to the group of hyporeactors and his curves are flattened throughout the postoperative period. Such patients with extensive arterial and venous thrombosis are frequently affected by spreading thrombosis or embolism following operation. H. Z., massive gangrene of foot, amputation.

Patient 1, R. S., has been under our observation for several years with rheumatic heart disease, auricular fibrillation, and multiple emboli to extremities and brain. This curve was obtained during one of her numerous admissions, 4 days after a popliteal embolus. Patient 2, E. B., has had coronary and peripheral arterial thromboses on an arteriosclerotic basis. Patient 3, M. R., had a low grade thrombophlebitis in large saphenous varicosities. Patient 4, M. M., has had rheumatic heart disease, auricular fibrillation, and five peripheral emboli with three embolectomies. This curve was obtained within 24 hours of the fourth femoral embolus. Patient 5, P. S., had a cerebral thrombosis 48 hours prior to the curve shown. Cases 3, 4, and 5 showed no response to heparin, whereas, cases 1 and 2 showed some elevation of the coagulation

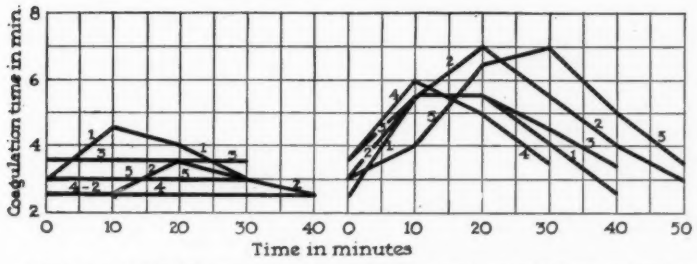

Fig. 6. a, On the left are shown the curves of 5 patients who have suffered an acute vascular occlusion within a few days prior to these determinations. As a control, b, on the right are the curves of patients, in whom the vascular accident had occurred several weeks or months previously.

time, but the response was below the normal average. As a control Figure 6, b shows the curves of five patients equally afflicted with vascular thromboses but not in a stage of an acute occlusive episode. Patient 1 is F. M. with chronic coronary sclerosis. Patient 2 is S. B., who has had coronary arterial disease for years with angina on effort, but no recent vascular occlusion. Patient 3, E. K. A., had neurocirculatory asthenia. Patient 4 is A. P., who suffered a coronary occlusion 3½ years previously but has had no other episode. Patient 5, M. N., had a chronic thrombophlebitic induration due to an old iliofemoral thrombosis. Her curve was somewhat atypical as it rose slowly, reached the peak of 7 minutes as late as 30 minutes, and did not return to normal for 50 minutes. It is not a subnormal but a delayed response.

The question naturally arises whether the diminished response to heparin is the expression of a change in the clotting factors preceding or following thrombosis. An opportunity presented itself during the treatment of varicose veins to inquire into this problem. It is our custom to ligate the saphenous vein at its junction with the femoral and then inject rather large amounts of hypertonic solutions to produce a thrombosis of at least the segment of the saphenous vein ending at the knee. Thus a rather massive thrombus is produced. It is interesting to note that the presence of such large masses of thrombi does not alter the heparin curves after their production. Figure 7 shows an average of three curves before and 24 hours after vein ligation and massive injection. This graph illustrates the fact that minor operations with slight tissue injury do not alter the postoperative heparin curve and also that the presence of a massive thrombus itself does not seem to influence it. It must be emphasized, however, that such an artificial thrombus differs from a spontaneous one in that an irritative endophlebitis has been the primary cause of thrombosis and that this thrombus is not in

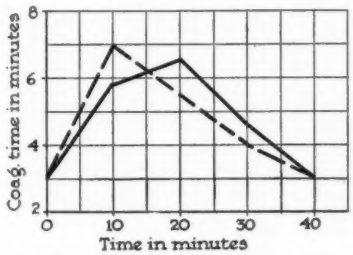

Fig. 7. Heparin curves, average, in 3 cases before (—) and after (———) ligation of saphenous vein followed by retrograde thrombosis. Note that there is little, if any, change in the response to heparin.

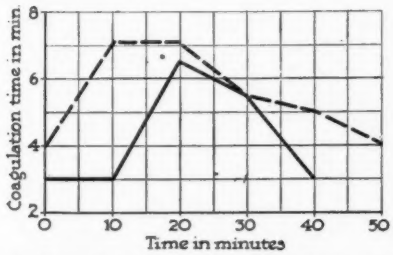

Fig. 8. Note that following ligation of the femoral vein the delayed response to heparin becomes normal. The thrombosis has been eliminated from contact with circulating blood. _._._, Before ligation; ———, after ligation.

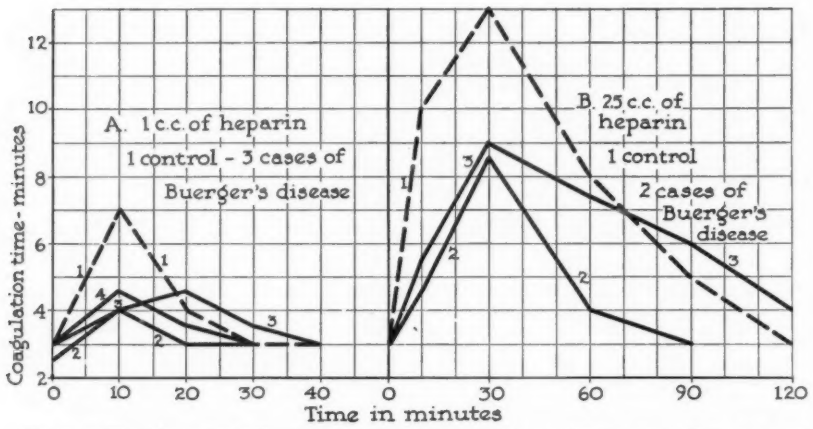

Fig. 9. a, Heparin curves in Buerger's disease. Case 1 was in a quiescent stage, Cases 2, 3, and 4 were examined in acute phase of the disease. On the right side of the graph, b, one can observe that larger doses of heparin (2.5 c.c.) also meet increased resistance in Buerger's disease. Should such a patient be heparinized, larger or more frequent doses are necessary to effect a satisfactory prolongation of coagulation time.

contact with the general circulation as the vein above the clot is tied and cut. Thus any kinase generated in the thrombus cannot be absorbed from here as even the perivenous lymphatics are blocked by the transsection of the vein. This possibility is suggested by the curves of R. B., a patient suffering from a deep venous thrombosis of about 10 days' duration. His heparin response was slightly delayed. At 10 minutes there had been no rise of the clotting time, although at 20 minutes a good response had been elicited. However, 24 hours after the femoral vein had been tied and the thrombus thus eliminated from contact with the circulating blood, the response was far quicker and lasted longer (Fig. 8).

C. Buerger's disease. Six patients are available for study (Fig. 9). In a, are shown 4 cases. Case 1, L. F., a 50 year old male, had acute and recurrent attacks of Buerger's disease for many years. At the time of examination the process was entirely quiescent with a normal sedimentation rate. There were multiple segmental occlusions. Case 2, P. B., was examined during a recurrent attack. Case 3, B. W., had a marked peripheral type of Buerger's disease, with acute swelling, pain and rubor of toes. Case 4, M. M., developed a segmental phlebitis in one arm with previously closed pedal arteries. With the exception of the first patient, all others represent an active stage and show a diminished response to heparin. In b, 2 other patients are shown who happened to receive 2.5 cubic centimeters of heparin. To this dose, both of them show a diminished response. As a control, an average of 5 normals is shown when this dose is given. Case 2, N. F., is a moderate progressive type of Buerger's disease, necessitating a sympathectomy. Case 3, J. D., is a severe juvenile Buerger's disease with involvement of all four extremities, the coronary and retinal vessels.

It is notable that without exception patients suffering from Buerger's disease, unless they are in a stage of complete remission, are hyporeactors. It is possible that with increasing experience, the heparin response may prove to be a good measure of the activity of the disease.

THE HYPERREACTOR GROUP

When the coagulation curve reached or exceeded the level of 7½ minutes after the injection of 1 cubic centimeter of heparin, the patient was labeled as a hyperreactor. The dividing line between normal and hyperreactors is of course entirely arbitrary. We have seen in this group of 87 patients 8 individuals whose reaction to heparin was exaggerated. Together with the increased

response to such a small dose of heparin 7 of the 8 patients showed flushing of the face, dyspnea, choking, constriction of the chest, and a feeling of faintness, characteristic of sensitization phenomena. That these clinical symptoms should be accompanied by a prolongation of coagulation time is significant in the light of a similar clotting phenomenon in anaphylactic reactions.

Figure 10 shows the curve of some of these patients. Patients 1 to 4 were severe hypertensives. Patient 5 was a diabetic, a pituitary dwarf. Patient 6 had undiagnosed attacks of dyspnea and fainting and a 5 per cent eosinophilia. She showed a marked allergy to heparin. Patient 7 had varicose veins with no history of any allergy. Six of the 8 patients had never received any heparin before. The other 2 had had injections of heparin less than a week prior to the dose which produced the reaction. The first dose did not produce any symptom nor was the curve obtained higher than normal.

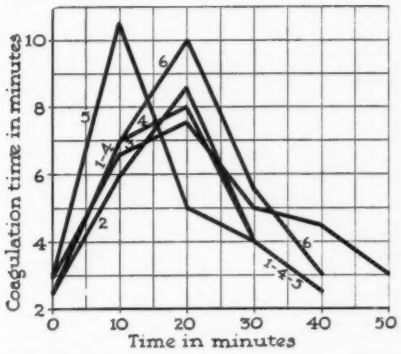

Fig. 10. The curves of 6 patients, showing increased sensitivity to heparin. This hyperreactor group showed phenomena of sensitization and constituted approximately 10 per cent of the total material studied.

CLINICAL APPLICATION OF HEPARIN CURVE

The graphs presented allow certain conclusions, whereas, many other angles of this problem are now being studied. One obvious conclusion is the great variability of the individual in its response to heparin. Of the 87 patients, only 47 acted normally, 36 were hyporeactors and 8 showed an exaggerated response. The large number of abnormal responses is naturally related to the type of material studied.

Of considerable surgical interest is the finding of the heparin resistance during the first 3 or 4 days following major operations. Many operations, especially those in which minimal tissue damage is produced, do not show a flattening of these curves. This hyporeactivity to heparin occurs simultaneously with a slight but definite lowering of the platelet count and probably other physicochemical changes, all of which relate to trauma to the tissues. It is our impression that postoperative thrombosis starts at this early period and not between the 6th and 10th days when the prothrombin level increases concomitantly with a thrombocytosis (14). It is likely that this is the period when the initial thrombus becomes clinically manifest as it spreads to longer segments of the vein. Obviously then, patients are most in need of heparin during the first 3 days after operation. If they can be mobilized after this period the administration of heparin may be discontinued. While we have heparinized patients for 10 to 12 days after operation, during the last year we have limited its administration to the first 3 days. This method, of course, is only applicable to the prevention of thrombosis and not to its treatment, which should be carried out until the thrombus is reasonably firm, namely, 10 to 12 days. Even so, cases are on record in which emboli appeared 20 to 30 days after a clinically manifest thrombosis. For a prolonged treatment with anticoagulants, heparin is not as suitable as the orally administered dicoumarin.

In this paper, we are not discussing the action of dicoumarin, the extract of spoiled sweet clover, except as it relates to the administration of heparin. The literature on dicoumarin has been summarized recently in a number of papers (1, 2, 10, 16). While dicoumarin is easy to administer by daily oral doses, the dosage is difficult to control. In fact, at present it is unsafe to administer it at all, without a daily determination of the prothrombin level, which limits its use to large hospitals. In our experience, purpura, hemorrhages, toxic rashes may occur. There is a marked variability of individual response.

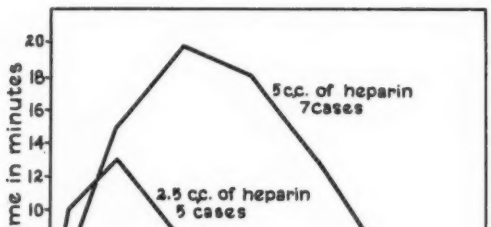

Fig. 11. The effect of increasing doses of heparin on the duration of prolonged coagulation time. In this small group, the effect of 1 cubic centimeter (10 mgm.) wore off in 40 minutes, of 2.5 cubic centimeters (25 mgm.) in 2 hours, and of 5 cubic centimeters (50 mgm.) in 3 hours.

One patient, who received a single 200 milligram dose of dicoumarin, showed a prolongation of prothrombin time from 18 to 60 seconds with the Smith bedside test. Another patient, who was maintained on daily doses of 100 milligrams with a satisfactory level of prothrombin, suddenly became resistant to this dose following an amputation and in fact developed an embolus while receiving the drug. We mention this only to indicate the difficulty of administration. At present we use heparin in intermittent doses for 3 days following an operation, which we suspect might lead to thrombosis. The selection of this endangered group is made by (1) a flat preoperative heparin curve, (2) history of previous thromboses, and (3) certain operations or injuries in older age groups which are followed by a high incidence of thromboses such as abdominal hysterectomies, ventral herniotomies, fractured pelves or hips. Certainly no one could run heparin curves before every operation.

In the treatment of an existing thrombosis, venous or arterial, we again heparinize the patient for 3 days, but simultaneously administer dicoumarin by mouth. One can give 300 milligrams the first and 100 milligrams the second day or, as State and Bullowa proposed, give a single dose of 400 milligrams, the effect of which lasts approximately 6 days. In spite of negative liver function tests during the administration of this drug (1, 2, 10, 16) the presence of liver damage cannot be excluded. Great caution is recommended in using this drug for more than a short time, such as for weeks and months in small doses. A prothrombin level of around 40 seconds (50 per cent of normal) should be maintained.

The occurrence of sensitization phenomena following the use of heparin makes it imperative to use a small dose, such as we have suggested, before therapeutic or prophylactic heparinization of the patient is started. The purest preparations of heparin contain about 2 per cent nitrogen (Jorpes). Six of our 8 patients with allergic reaction had never had heparin before. If heparin is normally secreted into the blood stream, could a sensitization occur to the endogenous product? This question needs further study.

Nothing has been said so far about the method of administering heparin. We start now with the determination of a heparin curve with 1 cubic centimeter of the drug. If the patient shows a normal reaction to heparin, 5 cubic centimeters (50 mgms.) are injected intravenously every 3 or 4 hours during day and night. A coagulation time should be determined 1 hour after the injection and at least once more just before the next dose is given. The effect of 10 milligrams of heparin wears off in 40 minutes, of 25 milligrams. in 2 hours, of 50 milligrams in 3 hours (Fig. 11). It is important not to inject the following dose of heparin until the coagulation time has returned to its normal level as otherwise a stepladder type of elevation will result with coagulation times that are far too excessive. The reports on hemorrhages following the use of heparin are quite numerous (6, 8, 13). We have observed 2 severe hemorrhages requiring multiple blood transfusions before these precautions were observed. More than 50 milligrams of heparin need not be injected at one time. The 100 milligram doses given by some of the Scandinavian authors may produce excessive and sudden elevations of the coagulation time.

Two other methods of giving heparin have been tried. The first was the continuous

intravenous drip, which is still the most popular. The method is cumbersome for the patient, requires a special nurse to watch the rate of inflow and in spite of this precaution still results in marked fluctuations of coagulation time. We have kept patients for as long as 12 to 14 days under continuous intravenous administration, but the number of chills, reactions, and the painful immobilization of the arm have made us abandon this procedure.

One can also maintain an increased level of coagulation time by giving an initial dose of 25 milligrams and follow this 45 to 60 minutes later with hourly doses of 10 milligrams given intravenously. This type of administration would require hourly intravenous injections and would not be practical in hospitalized patients. During conditions of war, especially during transport, such a method has been suggested by Murray and Janes on the basis of animal experiments. One can maintain a coagulation time between 6 and 14 minutes with this procedure.

SUMMARY

1. A simple test of the clotting mechanism is suggested. A small amount of heparin is injected intravenously and coagulation times are determined at 10 minute intervals for 40 minutes.

2. A group of heparin resistant patients have been found. They are patients in the early postoperative period, patients following cardiovascular accidents, and patients suffering from Buerger's disease.

3. Conversely a group of hyperreactors have been discovered, who showed sensitization phenomena. They may have had or never had received heparin previously.

4. Some suggestions are made for the clinical use of heparin. A combination of heparin and dicoumarin is advocated.

REFERENCES

1. ALLEN, E. V., BARKER, N. W., and WAUGH, J. M. J. Am. M. Ass., 1942, 120: 1009.
2. BOLLMAN, J. L., and PRESTON, F. W. J. Am. M. Ass., 1942, 120: 1021.
3. CRAFOORD, C., and JORPES, E. J. Am. M. Ass., 1941, 116: 2831.
4. D'ALESSANDRO, A. J. Surg. Gyn. Obst., 1942, 74: 62.
5. DE TAKATS, G. Thrombosis and embolism in Christopher, F.: Textbook of Surgery, 3d ed. Philadelphia: W. B. Saunders & Co., 1941.
6. ERSHLER, I., and BLAISDELL, I. J. Am. M. Ass., 1941, 117: 927.
7. JORPES, E. Heparin, its Chemistry, Physiology and application in Medicine. London: Humphrey Milford, Oxford University Press, 1939.
8. KEYES, J. W., and SHAFFER, C. F. J. Am. M. Ass., 1942, 119: 882.
9. MASON, M. F. Surgery, 1939, 5: 541 and 618.
10. MEYER, O. O., BINGHAM, J. B., and AXELROD, V. H. Am. J. M. Sc., 1942. 204: 11.
11. MURRAY, G. Arch. Surg., 1940, 40: 307.
12. MURRAY, G., and JANES, J. M. Brit. M. J., 1940, 2: 6.
13. RICHMOND, E. L. J. Am. M. Ass., 1941, 118: 611.
14. SHAPIRO, S., SHERWIN, B., and GORDIMER, M. Ann. Surg., 1942, 116: 175.
15. STATE, D., and BULLOWA, J. Proc. Soc. Exp. Biol., N. Y. 1942, 50: 66.
16. WRIGHT, I. S., and PRANDONI, A.: The dicoumarin 3,3′-methylene-bis-(4-hydroxycoumarin). J. Am. M. Ass., 1942, 120: 1015.

Y-SHAPED OSTEOTOMY FOR CORRECTION OF OPEN BITE IN ADULTS

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OPEN bite, or apertognathia, is a condition in which there is a space between the upper and lower jaw; that is, between the maxillary and mandibular anterior teeth when the posterior teeth are in contact. Those having this deformity, which first of all tends to impair their appearance, are unable to incise; that is, to bite off food such as a piece of apple. They may have difficulty with mastication in general, and often have speech defects. Some are mouth breathers, not being able to keep their lips occluded, and are liable, therefore, to suffer from chronic pharyngitis, tonsillitis, and adenoids. The deformity may be due either to malformation or to improper reduction and immobilization of a fracture of the maxilla or mandible.

MALFORMATION

In many cases open bite is believed to be due to thumb and finger sucking and abnormal tongue habits. There is considerable clinical evidence, however, that open bite in many cases is due to inhibited development of the premaxillary area, which is derived from the frontonasal process in the embryo (Fig. 1). This underdevelopment may be due to diseases affecting the normal development of the skeleton and causes arrested vertical growth of the alveolar process and teeth in this region. It is often associated with hypoplastic defects in the enamel and has been observed in rickets (Fig. 2). In another case of rickets open bite was found to be due to a downward bending of the lower jaw caused by the pull of the depressor muscles.

In determining the etiological factors in these cases, it should be remembered that tongue habits may have developed because of the malformation rather than caused by it, although it must be admitted that they probably act as a contributory cause in most cases. In these malformations the open bite always causes an angulation in the occlusal curve in either the upper or lower jaw, or both. A distinct downward bend in the anterior part of the mandible is known as *ectopia* of the jaw.

Another type of open bite is said to be caused by arrested vertical development of the ramus. This malformation is characterized by the fact that only the last molars on each side are in occlusion and the rest of the bite is open, the space between the teeth increasing gradually without there being any angulation. A case of this type of malformation is shown in Figure 3.

According to an analysis of 115 children with open bite made by Swinehart, 73 involved the incisors only, 25 the incisors and canines, 11 the incisors, canines, and one or both premolars, and in 1 case the malformation included the first molar. The remaining 5 cases did not include the anterior region.

MALUNITED FRACTURES

Open bite may be the result of faulty reduction or poor immobilization with ineffective control of muscle pull. It occurs in three types of fractures, as follows:

1. In complete horizontal fracture of the maxilla, when the pull of the pterygoid muscles causes a backward and downward displacement of the posterior part of the upper jaw, opening the incisor bite (Fig. 4). This deformity can best be remedied by refracturing the maxilla by horizontal submucosal division of the five vertical walls, the outer surface on both sides, and the nasoantral walls of the upper jaw, and the nasal septum.

2. In fractures of the horizontal ramus, if the downward pull of the anterior part of the mandible by the depressor muscles of the jaw is not effectively prevented by proper fixation on the anterior part of the dental arch (Fig. 7).

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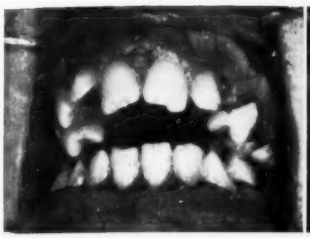


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

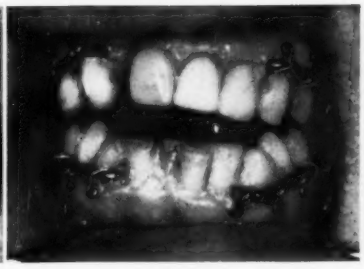


Fig. 5.

Fig. 6.

Fig. 7.

Fig. 1. Underdevelopment of the premaxilla causing open bite.

Fig. 2. Child, 11 years old with a history of rickets, presents underdevelopment of the premaxilla and hypoplastic defects in the incisor teeth.

Fig. 3. Open bite due to arrested vertical development of the ramus; only the third molars occlude in this case.

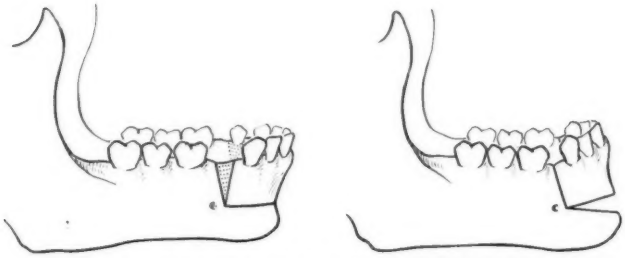
Fig. 4. Open bite resulting from improper reduction of horizontal fracture of mandible.

Fig. 5. Bilateral fracture posterior to the second molar with malunion causing open bite.

Figs. 6 and 7. Patient sustained a triple fracture of the mandible at the symphysis and neck of the condyle on each side. The x-ray examination disclosed overriding (Fig. 6) which caused open bite (Fig. 7).

3. In bilateral fracture of the neck of the condyle. These cases are very frequent. In most of them the elevator muscles of the jaw cause overriding (Fig. 5). As a result, the ramus is shortened, and with the posterior molars acting as a fulcrum the upper and lower incisors are drawn apart (Fig. 6). In immobilizing such a fracture it is extremely important to prevent gradual opening of the bite through the action of the elevator muscles, the effect of which is increased if trismus sets in. The bite tends to open up when the intermaxillary ligation in the anterior region is not strong enough to overcome the tension of the muscle pull.

It is clear that in malunited fractures there are again two types of open bite. In one there is a gradual opening of the entire occlusal plane, due either to displacement of the maxilla or to shortening of the ramus. In the other



Figs. 8 and 9. Correction of open bite according to Hullihen. V-shaped section two-thirds through mandible.

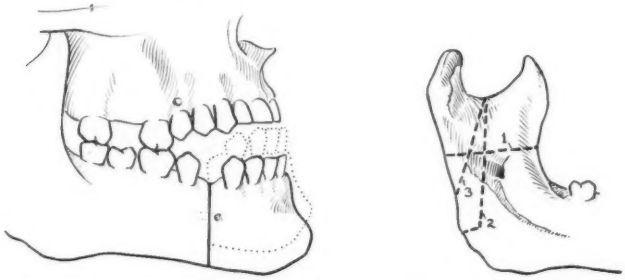


Fig. 10, left. Correction of open bite. Simple osteotomy according to Blair and vertical displacement of anterior fragment.

Fig. 11. Three methods for correction of open bite in the ramus. *1*, horizontal osteotomy first described by Babcock; *2*, oblique osteotomy in ramus after Limberg; *3*, oblique osteotomy at neck of the condyle according to Kostečka.

there is an angulation of the horizontal part of the mandible, either within or directly behind the dental arch. The two types, no matter whether they are caused by maldevelopment or by fracture, should be differentiated, since they require different kinds of treatment.

ORTHODONTIC TREATMENT

In children up to 12 or 14 years of age, malformations can be corrected by orthodontic procedures which tend to activate the underdeveloped section of the jaw, and by eliminating tongue habits which may interfere with the treatment. The older the patient, the less favorable is the outlook for obtaining a satisfactory result.

SURGICAL TREATMENT

In adults, excellent results can be obtained by surgical procedures. Operation, however, is indicated only in severe cases in order to correct definite disabilities, which include psychoses, the basis of which is the unattractive appearance caused by the deformity.

The first operation devised to improve a malformation of the jaw by surgical means was reported by Hullihen in 1849. The patient, a girl 20 years old, had a deformity due to traction caused by a scar from a burn on the neck, received 15 years previously. The mandible was bent down and the bite was open. The operation, performed without anesthesia and at a time when hemostatic forceps and antiseptics were unknown, consisted of the resection of a V-shaped section from each side of the mandible, including on one side a premolar tooth. This section extended only two-thirds of the way through the bone, at which point the saw was turned horizontally forward. Removal of the sections of bone permitted the loosened anterior portion of jaw to be pushed back and up (Figs. 8, 9).

Although this operation was successful, almost 50 years elapsed before a similar one was

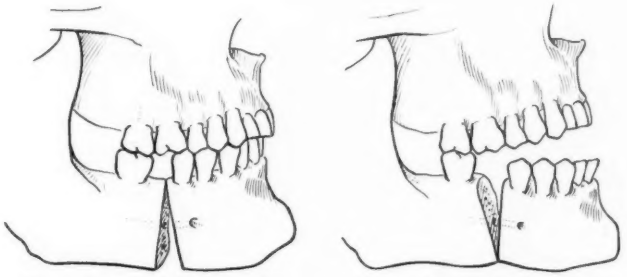
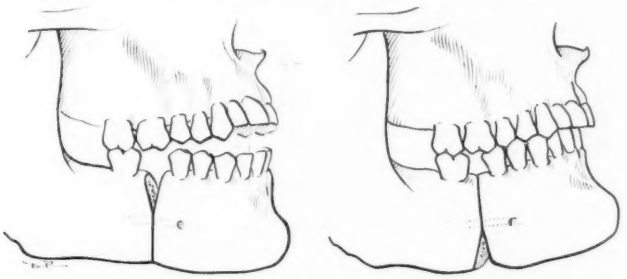


Fig. 12, left. Simple bilateral osteotomy causes V-shaped space to open when the anterior fragment is placed in position.
Fig. 13. Correction of open bite by a V-shaped excision of bone.



Figs. 14 and 15. Correction of open bite by Y-shaped excision in the horizontal ramus.

performed by Blair (1897). This and another operation were reviewed by Angle (1, 2) in 1898. One operation was performed at the Baptist Hospital in St. Louis, with excellent results; the other was performed at a hospital in New Orleans, and nearly cost the patient his life, with total loss of the mandible through necrosis. Failure was due to the fact that practically no support was given the segments of bone, Barton bandage and wiring of bone being depended upon for stabilization. (A crude wire ligature was placed on each side, but one dropped out 3 days after the operation.) Angle emphasized the importance of proper stabilization of the fragments after operation, and of removing a complete V-shaped or wedge-shaped section of bone.

Since that time only occasional reports on the surgical treatment of malformed jaws have appeared in the literature. Most of these articles deal with the lengthening or shortening of the jaws to correct either macrognathia or micrognathia—that is, protrusion or retrusion of the mandible—although open bite is occasionally included because it is likely to be combined with mandibular protrusion. In 1901 von Eiselsberg performed an operation similar to that of Hullihen on an ectopic mandible, the cause of which was a dermoid cyst. Lane, in 1905, and Pickerill, in 1912, who mentions the former, both performed wedge-shaped excisions in the premolar region extending through the whole thickness of the mandible. Mayrhofer, in 1916, also recommended the resection of a wedge-shaped section to transpose the anterior part of the jaw, but believed that the first molars should be extracted previously. Korth, in 1921, favored an operation in the horizontal ramus because it is the part of the bone involved in the anomaly. Blair, in his book, *Surgery and Diseases of the Jaws* (1927), recommended for certain cases a simple bilateral section of the horizontal ramus. This allows one to move the detached part of the jaw up into occlusion. The operation, however, is applicable only to cases in which the jaw does not need to be tilted, or set back. Many cases of open bite,

Fig. 16.

Fig. 16. Mouth of patient aged 18 years showing open bite deformity.

Fig. 17.

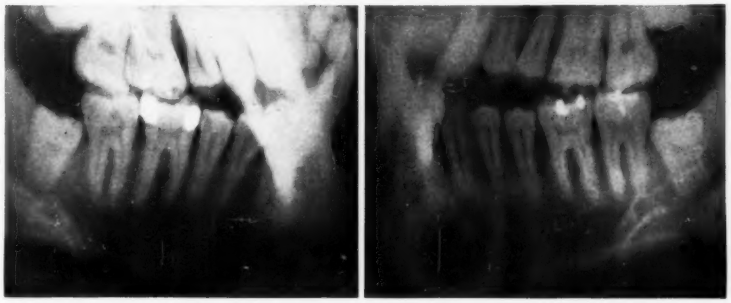
Fig. 18.

Figs. 17 and 18. Lateral views of the patient with open bite which extends to the first molar region.

however, are associated with some mandibular protrusion, even if not marked, and if the anterior segment in such cases is not tilted back, the lower incisors will protrude over the upper ones when brought into position. The illustration of Blair, of which Figure 10 is a copy, is a good example of the fact that simple osteotomy does not correct open bite satisfactorily. Blair himself stated that if the jaw needs to be tilted, as it does in most cases, it is necessary to remove a V-shaped section. If the jaw were tilted back after a simple osteotomy without a V-shaped resection a reversed V would open at the lower border of the mandible, as shown in the case described by Bruhn, in 1927, and illustrated in Figure 12. The resulting inadequate apposition of the fragments would prevent healing in many cases. The resection of a V-shaped piece of bone, as shown in Figure 13, has therefore been recommended by all who describe operations in the horizontal ramus. Blair recommends in addition an S-shaped cut, which, he states, has the advantage of not shortening the jaw. Kazanjian, in 1932, attempted a semicircular incision on one side with a special trephine; on the other side a surgical bur was used. The cutting with the trephine, he stated, was disappointing, but the bur worked very satisfactorily.

An entirely different approach has been suggested by Babcock, 1909. He described the case of a boy of 18 on whom he performed a bilateral transverse section of the ramus (Fig. 11, line *1*). He chose this operation to avoid reduction of the size of the dental arch and injury of the inferior alveolar nerve and vessels. He states, however, that the operation in the ramus is indicated only in cases in which careful study shows that a fair occlusion can be attained without changing the angulation of the dental arch.

Limberg, 1926, a Russian surgeon, also advised that an operation be performed in the ramus, but again only for cases in which open bite is caused by deficiency in that part. His operation to elongate the ramus consists of an oblique osteotomy performed from an incision below the angle of the jaw. The bone is cut beginning at the mandibular notch, with a backward and downward sloping to the posterior margin of the ramus (Fig. 11, line *2*). Limberg pointed out that obstacles to success with this method are the stylomandibular ligament and the elevator muscles attached to the posterior part of the jaw, which may prevent the bringing down of the mandible. The muscles may gradually cause retraction after the operation, for which reason he recommended overcorrection. Kostečka, 1934, like Babcock, favored an operation beyond the dental arch. He recommended a section at the neck of the condyle (Fig. 11, line *3*). This operation as well as Babcock's can be performed with a Gigli saw and has the advantage of an easy technique. None of the operations performed in the ramus, however, allows a change in the angulation of the mandible. They are indicated therefore, only for cases in which the deformity is due to underdevelopment or shortening of the ramus, and not for the commoner type of open bite in which angulation in the dental arch has to be overcome.



Figs. 19, left, and 20. Roentgen examination of the jaws showing contact of the molars, caries in the left first molar underneath a filling, and a thick, heavy cortex of the jaw.

Planning of treatment. The treatment should be carefully planned after a thorough study has been made of the deformity. Open bite due to underdevelopment or shortening of the ramus should be carefully distinguished from that due to angulation within the dental arch. The first type of deformity calls for correction in the ramus, the second for an osteotomy just anterior to the last tooth in occlusion. As the simple osteotomy is inadequate in most cases, excision of a section of bone is indicated to allow tilting up of the anterior part of the jaw. The V-shaped excision, which is generally performed from an intraoral approach, has two decided disadvantages. First, it involves the mandibular nerve and artery, which are generally severed; second, it causes considerable retrusion and slanting of the lower incisor teeth, owing to the amount of tilting necessary to correct excessive open bite when associated with only moderate or no mandibular protrusion. The latter disadvantage may be overcome by a modification of the conventional procedure consisting of a combination of the V-shaped excision and straight osteotomy, a method that may be designated as the Y-shaped excision.

Y-SHAPED EXCISION IN HORIZONTAL RAMUS

The Y-shaped excision has the advantage of facilitating the preservation of the mandibular nerve and artery and of causing only a small amount of retrusion of the jaw. While the numbness from cutting the mandibular nerve which generally follows complete sectioning of the jaw from an intraoral or extraoral approach is not usually permanent, it causes embarrassment to the patient because of the dribbling of saliva and dropping of food associated with it. Avoidance of this complication is therefore highly desirable.

This operation is especially indicated in cases of open bite with little or no mandibular protrusion, but it can be adapted to cases in which protrusion is marked. In such cases a rhomboid section is removed in two parts, in a similar manner as New and Erich, 1941, excised a parallel section for correction of prognathism. The first part of the rhomboid piece, wider on the top than on the bottom, is removed by an intraoral approach above the mandibular canal; the second and narrower part below the mandibular canal is excised by an extraoral approach. The operation serves to shorten the jaw and at the same time to tilt it up without injury to the nerve and vessels.

Technique. The Y-shaped excision consists of an intraoral and an extraoral operation, performed on both sides of the jaw. After the former is finished the latter follows with a complete new sterile set-up. This procedure may take a little longer than the V-shaped excision, which can be done intraorally, but it repays extra time by giving a much better result.

The intraoral stage consists of cutting out a short V-shaped piece, the apex of which extends to the mandibular canal. The lower part of the mandible is cut in a vertical direction from the inferior border up to the mandibular canal, leaving a thin strand of

Fig. 21. Splint designed by Dr. Maynard E. Cohen inserted before the operation.

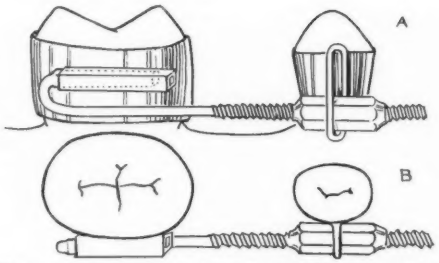


Fig. 22. Accessory to the splint applied immediately after the operation to hold fragments in contact.

bone which contains the nerve and artery (Figs. 14 and 15). This bridge can be fractured by forcing the anterior part of the mandible into the correct position, as will be described. On positioning of the mandible, the V-shaped space in the alveolar process closes and a reversed V-shaped space opens at the lower border of the jaw.

The operation is performed at the place where the mandible is angulated, or where the open bite begins. Unless there is an edentulous space on one or both sides, a tooth must be extracted. This can be done 2 or 3 weeks before the operation, or at the time the osteotomy is performed. An arch-wire splint, however, must be constructed and cemented into place beforehand.

ILLUSTRATIVE CASE

The case used to illustrate this procedure is that of a patient 18 years of age, who when young had a habit of thrusting his tongue between his teeth. He was in perfect health but had been rejected by the Air Corps because of an open bite extending from the first molars forward, as shown in Figures 16, 17, and 18. He came to me with the request to have this deformity corrected surgically. X-ray photographs were taken of both sides (Figs. 19 and 20). I decided to remove the first molar on each side in order to create the necessary space to perform the Y-shaped excision just described. One of the molars was affected by deep secondary caries, and there appeared to be a good chance that the third molars, when erupting, would push the second molars forward and partly close the space.

The splint. A splint was designed and constructed by Dr. Maynard E. Cohen. It consisted of bands cemented to anchor teeth to which an arch wire was connected. The arch wire contained lugs for intermaxillary ligation, as shown in Figure 21. In the mandible it extended only to the tooth behind which the osteotomy was to be performed. A second detachable and adjustable appliance was prepared which has the purpose of drawing and holding the cut ends of the mandible in contact. The end of this appliance was made to fit into a square tube soldered to the molar

Fig. 23.

Fig. 24.

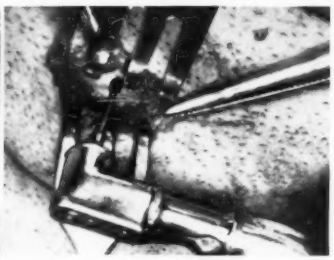
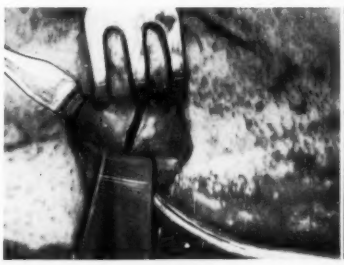


Fig. 25.

Fig. 23. Gingival flap prepared on buccal side of the lower first molar.

Fig. 24. After extraction of the first molar, a V-shaped section of bone was removed.

Fig. 25. Incision at the lower border of the mandible and cutting drill holes through the lower part of the bone.



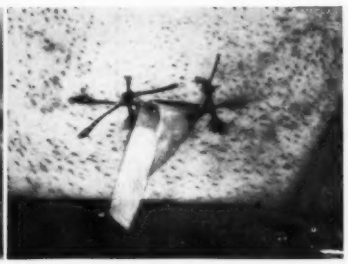


Fig. 26, left. Vertical cut completed with bone chisel.
Fig. 27. Incision closed with rubber-dam drain inserted.

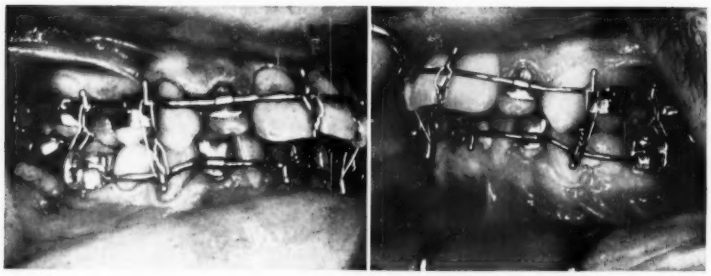
band. This arrangement made it possible to place the extension wire bar in any of three positions, so that it could be placed over, under, or on the buccal side of the tube. The anterior threaded part was made to pass into a vertical loop soldered to the premolar band. This made it possible to lock the appliance by turning the two nuts on each side of the loop against each other when the artificial fracture had been properly reduced (Fig. 22).

The operation. Intravenous pentothal sodium anesthesia was administered by Dr. Lewis Dretler. Intravenous anesthesia eliminates vomiting, which is undesirable when intermaxillary ligation is employed. The patient had the usual preoperative medication with atropine, 1/100 grain. The pentothal was given in fractional doses by means of an intravenous drip, which maintains water balance. An endotracheal catheter was inserted through the nose so that the throat could be packed to prevent aspiration of blood and fluids during the operation. Some nitrous oxide and oxygen or plain oxygen was also administered at intervals during the operation through this tube.

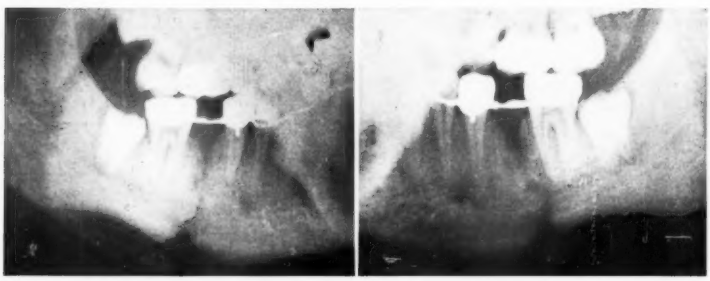
The intraoral procedure consisted of the extraction of the tooth on each side. A gingival flap was first prepared by making incisions at the anterior and posterior limit of the tooth socket on the buccal side, carrying them down over the alveolus in a divergent manner so that the pedicle of the flap was wider than the peripheral end (Fig. 23). The bone was thus exposed and a V-shaped section cut out on each side by means of burs and a chisel (Fig. 24). Care was exercised not to cut beyond the mandibular canal.

The extraoral procedure was done with a new sterile set-up, including instruments. An incision 5 to 6 centimeters in length was made below the inferior border of the mandible, its outer surface being exposed without cutting the external maxillary artery. After carefully locating the apex of the V so as to connect with it, a vertical incision was made in the periosteum. The cortex of the bone was then perforated with a bur (Fig. 25), after which the chisel was used to complete the cut (Fig. 26). This required considerable force, since the cortex of the patient's jaw was unusually heavy, as seen in the x-ray films of the mandible. The bone, although cut from both sides, was not completely severed at this time, however; a little span was left, protecting the nerve and vessels of the jaw. After the vertical cut had been completed on the other side of the jaw in the same way, the chin was pressed upward with one hand to complete the artificial fracture. It was necessary to aid this procedure by inserting a chisel into the cut, first on one side and then on the other, in order to apply force on the anterior segment. The detached part was now very loose, and care had to be exercised so as not to displace it, for fear that the nerve and artery might be drawn out of the canal and later form a loop that might be caught between the fragments when brought together. While the chin was supported by the assistant, the skin incisions were closed with sutures. Rubber-dam drains were next inserted between the sutures on each side to prevent the formation of a hematoma (Fig. 27).

Immobilization. The operation was continued in the mouth. First, the mucosa was



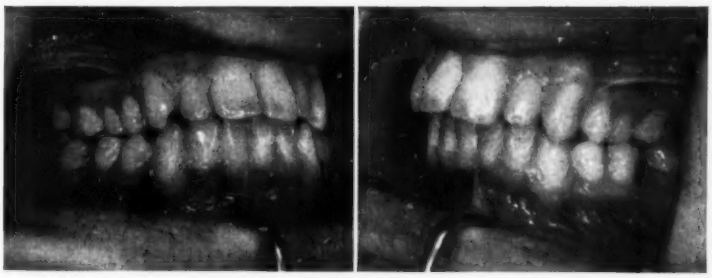
Figs. 28, left, and 29. Anterior part of the mandible positioned and stabilized by the appliance.



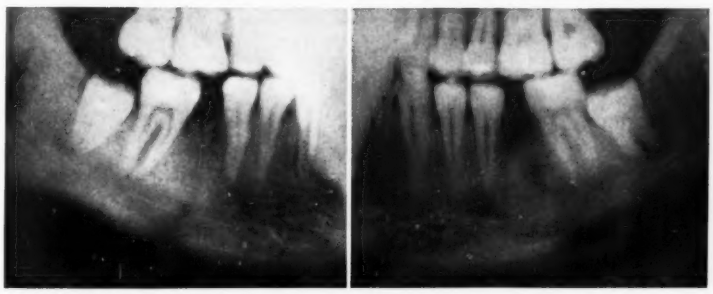
Figs. 30, left, and 31. Roentgen examination 6 weeks after the operation at the time when the appliances were removed.

sutured into place on each side with silk. Then the mandible was placed so that the teeth attained the best occlusion possible. The detachable appliances were inserted and adjusted to bring the posterior fragments into good contact with the anterior one. Care was taken to bring the posterior mandibular molars into occlusion with the maxillary ones. The premolars had to be shaped by judicious grinding so as to occlude with their antagonists. This is necessary in most cases because teeth that have never occluded may not fit properly when brought together. The jaws were completely immobilized by intermaxillary ligation (Figs. 28 and 29). The intermaxillary wires were placed so that there was firm and strong fixation in the incisor region to counteract the pull from the geniohyoid and digastric muscles.

Postoperative care. There was only slight edema following the operation. Ice was applied to the jaw for the first 24 hours. In spite of all precautions, such as the use of the endotracheal tube, aspiration of accumulated mucus in the bronchi after the operation, and changing the patient's position in bed every half-hour while he was unconscious, he developed pneumonia on the second day. The temperature was 106.5 degrees F., pulse 160, respirations 60, and x-ray examination showed evidence of lobar pneumonia. The white cell count was 12,400 with 86 per cent neutrophils, 5 per cent young neutrophils, and 9 per cent lymphocytes. Fluids were given intravenously and, at the recommendation of Dr. C. A. Janeway, 5 grams of sulfadiazine was administered promptly by the same method. An oxygen tent was installed, and the sulfadiazine was continued, two tablets being given by mouth every 4 hours. The sulfadiazine level in the blood was maintained between 10 and 12 milligrams per 100 cubic centimeters. Dr. R. H. Overholt was asked to take charge of the pulmonary complications, and owing to his skillful treatment combined with careful nursing, the patient completely recovered. He was discharged one month after admission.



Figs. 32, left, and 33. Photographs taken 5 months after the operation showing correction of open bite.



Figs. 34, left, and 35. Roentgen examination 5 months after operation showing complete filling in of the bone.

The drains were removed on the 2d postoperative day, and when the patient was able to take nourishment a liquid diet was prescribed, such as is given in ordinary fracture cases. The mouth was kept as clean as possible by means of a toothbrush and irrigation with a syringe after meals.

The skin sutures were removed on the 5th postoperative day and the intraoral ones 2 days later. The position of the jaw was checked by x-ray as soon as the patient's condition permitted. The findings were satisfactory and no further adjustments had to be made. However, a small sequestrum was located in the V-shaped opening at the right lower border of the mandible. A swelling appeared a few days later and a fistula opened in the incision. This was irrigated daily until two small pieces of bone were expelled, when the opening closed. The left side healed without complications.

The intermaxillary wires were removed after 6 weeks, when the mandibular splint alone was sufficient to hold the lower jaw together. Eight weeks after the operation x-ray pictures were taken again and disclosed satisfactory union. The V-shaped space at the lower border had begun to fill in with bone, as shown in Figures 30 and 31. I therefore removed the attachments which were holding the fragments together, and when it was possible for the patient to eat without further discomfort the entire appliance was removed.

Examination 5 months after the operation showed satisfactory adjustment of the open bite (Figs. 32 and 33). It is interesting to note that the second molar had drifted forward, partly closing the space created by the extraction. It can be expected that in a patient 18 or 19 years old this space will in time close completely, making room for the third molar to erupt and improving the posterior occlusion. Another set of x-ray films taken at this time, showed complete healing (Figs. 34 and 35).

The end-result was extremely satisfactory; the scars on the face were trivial, and after recovery the patient was accepted for the Air Corps.

SUMMARY

The various methods devised in the past for correction of open bite are reviewed.

Open bite with angulation in the occlusal plane, which may be due either to maldevelopment in the anterior part of the jaws, or to faulty reduction of a fracture in the horizontal ramus of the mandible, is best corrected within the dental arch.

A new method, termed the Y-shaped excision, for the surgical correction of open bite in adults with little or no mandibular protrusion is presented. The method is especially useful in cases with angulation of the mandible in the premolar or molar region.

The method is an improvement on the V-shaped excision. The operation is performed from both an intraoral and an extraoral approach, and therefore requires more time than the former procedure. This is justified, however, because it prevents injury to the alveolar nerve and vessels and gives a more accurate result.

REFERENCES

1. ANGLE, E. H. Dent. Cosmos, 1898, 40: 635.
2. Idem. Treatment of Malocclusion of the Teeth and Fractures of the Maxillae. 7th ed., p. 572. Philadelphia: S. S. White Dental Manufacturing Co., 1907.
3. BABCOCK, W. W. J. Am. M. Ass., 1909, 53: 833.
4. BLAIR, V. P. Surgery and Diseases of the Jaws. St. Louis: C. V. Mosby Co., 1927.
5. BRUHN, C. Internat. J. Orthodont. 1927, 13: 65.
6. EISELSBERG, E. VON. Wien. klin. Wschr., 1906, 19: 1505.
7. HULLIHEN, S. P. Am. J. M. Sc., 1849, p. 157.
8. KAZANJIAN, V. H. Internat. J. Orthodont., 1932, 18: 1224.
9. KORTH, P. Vjschr. Zahnh., 1924, 40: 272.
10. KOSTEČKA, F. Internat. J. Orthodont., 1934, 20: 1082.
11. LANE, W. A. Cleft Palate and Hare Lip. London: The Medical Publishing Co., 1906.
12. LIMBERG, A. Dent. Cosmos, 1925, 67: 1191.
13. MAYRHOFER. Erg. d. Zahnh., 1916, 5, no. 2.
14. NEW, G. B., and ERICH, J. B. Am. J. Surg., 1941, 53: 2.
15. PICKERILL, H. P. Dent. Cosmos, 1912, 54: 1114.
16. SWINEHART, E. W. Am. J. Orthodont., 1942, 28: 18.

OSTEOCHONDROMA OF THE CORONOID PROCESS OF THE MANDIBLE

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OSTEOCHONDROMA of the coronoid process of the mandible is uncommon. We have been unable to find in the literature any specific description of the lesion, its diagnosis, or its treatment. It is our purpose to discuss two such cases.

CASE 1. F. K., a boy of 15 years, first came to the Johns Hopkins Hospital in June, 1936, complaining of painless progressive swelling of the left side of the face for 3 years. Except for the fact that forceps had been used at his birth, there was no history of trauma. He was known to have congenital syphilis. Examination showed an extremely hard swelling, 3 by 4 centimeters, in the left zygomatic region. There were no signs of inflammation, the overlying skin was normal, and the movements of the jaw were normal. The blood Wassermann test was 4 plus, the spinal negative. Roentgenograms taken at that time were interpreted as showing a tumor of the soft tissues producing distortion of the coronoid process of the mandible and of the zygoma. Intensive antisyphilitic treatment was instituted, but the swelling continued to increase in size. Limitation of motion of the jaw was first noticed in 1940. On readmission to the hospital in January, 1942, the growth measured 6 by 4 centimeters and felt as hard as bone. The mouth could be opened only half an inch, and occlusion was imperfect. The Wassermann test was positive. Roentgenograms taken at this time (by W.H.B.) showed a large exostosis springing from the coronoid process and extending upward, outward, and forward, impinging on, and distorting, the zygoma (Figs. 1 and 2). There was a false articulation at this point. The bony tumor was removed (by R. T. S.) with restoration of the function of the jaw. Convalescence was uneventful.

CASE 2. H.P.O., male, age 19 years, was admitted to the Johns Hopkins Hospital on March 29, 1942, complaining of limitation of motion of the jaw for 2 years. The disability had previously been attributed to impacted wisdom teeth; these had been extracted with subsequent severe local infection but with no improvement. Later wedges between the teeth had been used without benefit. At the time of admission, prominence of the right zygoma was noted but nothing suggesting a tumor could be felt. There was no evidence of inflammation. The mouth could be opened only 1 centimeter but occlusion was good. The remaining physical examinations and the laboratory tests were negative. Roentgenograms taken from appropriate angles showed enlargement of the right coronoid process with erosion of the zygoma and the superior maxillary bone (Figs. 3 and 4). The tumor and part of the zygoma were excised (by R.T.S.). The postoperative course was smooth. Six months later the patient reported that he was without symptoms and that the jaw had an almost normal range of motion.

Osteochondromas in general are common tumors, appearing usually between the ages of 10 and 25 years; but some are thought to be congenital. They are benign. They frequently occur near the ends of the long bones, particularly at the site of attachment of the tendon which supplies the maximal degree of traction. A possible reason for this characteristic location is that at such a point a defect in the periosteum permits precartilaginous blastomas to escape or to be pulled out from the

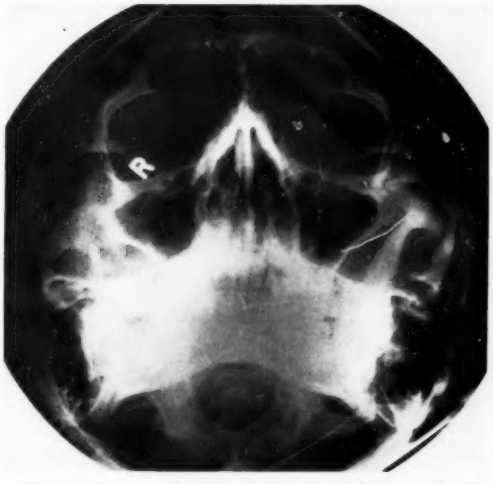

Fig. 1. Case 1. Examination made with the patient's head in the position generally used in examination of the nasal accessory sinuses. Expansion of the left coronoid process of the mandible is clearly demonstrated.

From the Department of Surgery and the Department of Roentgenology of the Johns Hopkins Hospital.

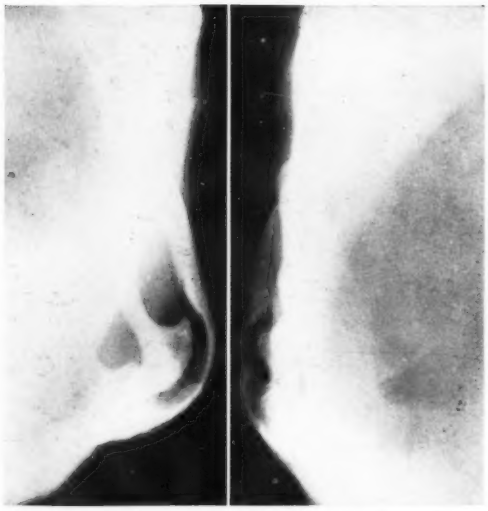

Fig. 2. Fig. 3.

Fig. 2. Case 1. Depicts expansion of the coronoid process and erosion of the zygomatic arch. In order to obtain this view it is necessary that the patient's head be partly rotated and the rays directed tangentially to the side of the head. The exact amount of angulation can be estimated after the taking of scout films and fluoroscopic examinations of the head and face. This projection produces some distortion but does supply the maximum amount of detail.

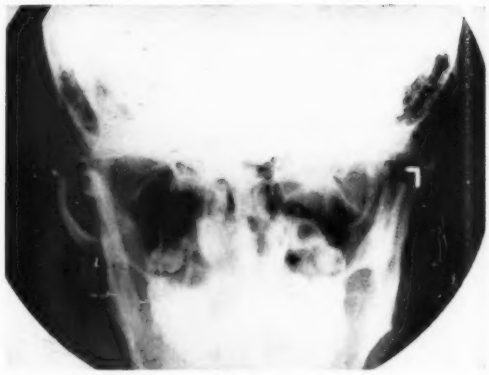

Fig. 4.

Fig. 3. Case 2. Examination made with the patient in the special position shows that the coronoid process has been removed and the zygomatic arch has been restored.

Fig. 4. Case 2. The posteroanterior projection shows lateral expansion of the coronoid process of the mandible and erosion of the inner surface of the zygomatic arch.

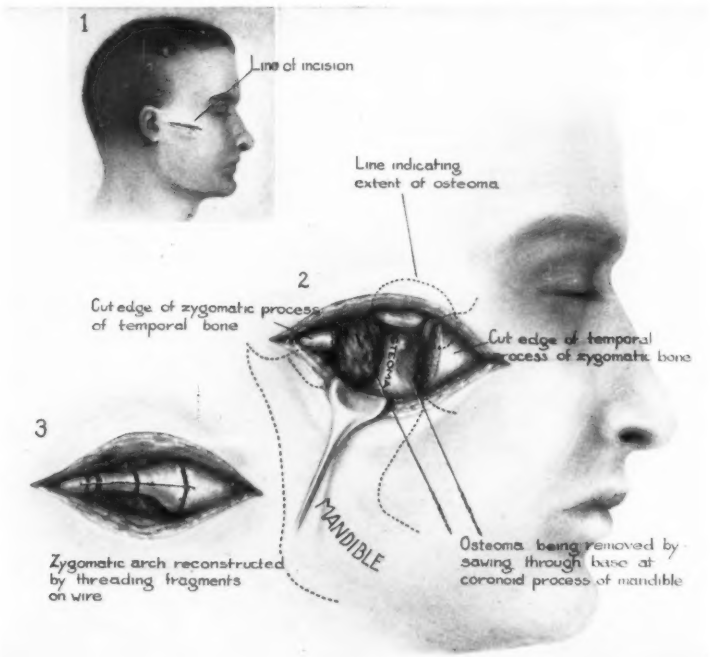
1
Line of incision
Line indicating extent of osteoma
2
Cut edge of zygomatic process of temporal bone
Cut edge of temporal process of zygomatic bone
Tumor
3
MANDIBLE
Zygomatic arch reconstructed by threading fragments on wire
Osteoma being removed by sawing through base at coronoid process of mandible

Fig. 5. Case 2. Steps in surgical removal of osteochondroma of coronoid process.

Fig. 6. Case 2. The special position graphically depicts the deformity of both the coronoid process and the zygomatic arch.

Fig. 7. Case 2. Roentgenogram which was taken after operation; the coronoid process of the mandible has been resected.

limiting membrane, and in time these cells produce the osteochondroma. The tumor characteristically has a stalk of normal appearing bone which terminates in a mushroom-shaped head that is capped with a layer of cartilage.

The tumors described in this paper were situated on top of the coronoid process, the site of insertion of the powerful temporal muscle. Except for this unusual location they were similar, pathologically and in rate of development, to osteochondromas found elsewhere.

The diagnosis of osteochondroma of the coronoid process is not easy. The true nature of the lesion in our first case was not recognized for several years, and it is probable that the second instance would have been missed also but for the experience with the first patient. The important points in diagnosis are slowly progressive, painless limitation of movement of the jaw in young persons, malocclusion in some cases, a bony hard swelling in the region of the zygoma, and the abnormal bony projection visualized by roentgenograms taken from the proper angle.[1]

[1]Dr. J. W. Pierson was of great assistance in the roentgenographic studies.

Treatment consists of surgical removal of the growth. The operative procedure used in these 2 cases follows: nitrous oxide, oxygen, and ether were administered through an intranasal intratracheal tube. An incision was made over the full length of the zygoma, thus exposing the bone (Fig. 5). The periosteum was incised longitudinally and was raised with an elevator so as to uncover the entire bony arch. A Gigli saw was then passed subperiosteally around the bone, and the zygoma was cut across at its anterior attachment to the malar bone. In our first case it was possible to repeat this maneuver at the posterior end of the zygoma and to lift the resected bone out intact. In the second case this procedure was not possible because of impingement of the tumor; consequently, the zygoma had to be removed in several pieces with the help of bone cutter and rongeur forceps. In both cases the tumor was beautifully exposed by removal of the zygoma. It was then possible to cut across the pedicle of the osteochondroma with a Gigli saw and remove it, whereupon the jaw at once regained its normal mobility. In the first operation some of the protruding malar bone was rongeured away so as to lessen the original deformity of the

cheek; then the resected zygoma was replaced and fastened at each end with stainless steel wire passed through drill holes (Fig. 6). In the second operation, in which the zygoma had been removed piece by piece, the fragments of bone were strung like beads on a strand of stainless steel wire and were in this way fastened in approximately their old position (Figs. 5 and 7). The soft tissues were closed with interrupted fine silk sutures and the skin was approximated with horsehair. The wounds were dressed with vaseline gauze, dry gauze, and a sea sponge for gentle pressure.

Each operation lasted about 2 hours, did not cause shock, and was not followed by any evidence of injury to the facial or trigeminal nerves, Stensen's duct, or oral mucous membranes. In both instances the patients were able to open the jaw freely the day after operation and masticated food with minimal discomfort. The temperatures by mouth did not exceed 100.4 degrees. Both wounds healed *per primam*, the sutures were removed on the 4th day after operation, and the patients were discharged on the 7th day.

SUMMARY AND CONCLUSIONS

Osteochondroma of the coronoid process of the mandible is believed to be rare. Two cases are presented in brief and the diagnosis and treatment are discussed. Although it is not wise to draw general conclusions from only 2 cases, certain clinical facts are worth noting:

1. Both patients were young males (ages 15 and 19 years).
2. There was no history of local injury.
3. Symptoms were slowly progressive over a period of years.
4. The leading symptom in both cases was painless, progressive loss of ability to open the jaw.
5. A late sign in both cases was increasing prominence of the zygoma of the affected side.
6. In each case routine examination by roentgenograms either did not show the tumor or else its true nature was not recognized.

REFERENCES

1. Ehrenfried, A. J. Am. M. Ass., 1917, 68: 502.
2. Geschickter, C. F. Am. J. Roent., 1935, 34: 1.
3. Meyerding, H. W. Radiology, 1927, 8: 282.
4. Rixford, E. Ann. Surg., 1930, 92: 673.

MAMMARY CANCER IN YOUTH

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THE general impression prevails that the prognosis in carcinoma of the breast in young women is unfavorable as compared to that in older patients. This impression is supported by the available literature. For example, Ewing states in his authoritative book, *Neoplastic Diseases* (1940): "Before 30 years of age mammary cancer is extremely fatal so that some surgeons prefer not to operate during this period." A survey of our own material at the tumor clinic of the New York Post-Graduate Hospital, indicated that, with proper radical surgical treatment, the outcome in breast cancer in young women is as favorable as in older patients.

Realizing that our own material was meager, we gained the co-operation of the surgical staffs of the Roosevelt Hospital, the New York Hospital, and the Lenox Hill Hospital in New York City, and the Pondville Memorial Hospital and the Massachusetts General Hospital in Boston. This enabled us to review 73 cases of mammary cancer in patients under 30 years of age.

Although this survey includes a relatively small number of cases, it is based on a larger group of cases than the reports of those who have postulated an unfavorable prognosis in this age group.

INCIDENCE OF BREAST CANCER AND AGE DISTRIBUTION IN PATIENTS UNDER THIRTY

Reviews (2) show that cancer of the breast is almost unknown in childhood and youth, and is rare in young adults.

Vital statistics[1] for 1930–1939 give the figures as shown in Table I, for deaths from cancer of the breast by color, sex, and ages in the United States.

Cancer of the breast in patients under 30 is more common among negroes than whites—the ratio is 2:1 in males and 3:1 in females which may be due to earlier maturity.

TABLE I.—DEATH FROM CANCER

	All ages	Under 30	Percentage
Males			
White	1361	14	1.0
Colored	134	3	2.2
Females			
White	113,415	751	0.6
Colored	7094	162	2.2
Total	122,004	930	0.7

From the Tumor Clinic, Department of Surgery, New York Post-Graduate Medical School and Hospital, Columbia University.

[1]U. S. Bureau of Census. Vital Statistics—Special Reports. Mortality Statistics.

Table II indicates deaths from cancer of the breast in patients under 30 years of age.

Further statistical study reveals that of every 1000 cases of cancer of the male breast in the white race, 10 patients are under 30 years of age; of every 1000 cases of cancer of the breast in the white female, only 6 are under 30 years of age.

On the basis of collected clinical material, it appears that cancer of the breast in patients under 30 constitutes 2 per cent of all breast cancers, while those under 20 constitutes 0.09 per cent of the total.

The earliest available report of a case of breast cancer in the young was published in 1851 by Cooper. The youngest noted in the literature was 10 years old, which Sears diagnosed as adenocarcinoma grade II; the other a patient 11 years old, Thompson also diagnosed as adenocarcinoma. Other examples of breast cancer among those under 20 include: 2 patients aged 12 (Blodgett, Levings); 1 aged 13 (Luttinger); 1 aged 14 (Carnett); 3 aged 15 (Chauvel, Nunn, Power, 16); 1 aged 16 (Harrington, 15); 3 aged 17 (Harrington, 15; Winslow and Heitzmann); and 1 aged 18 (Kaufmann). There was a 12 year old boy in this group (Blodgett) and another 15 years of age (Bryant). The rarity of cancer in patients under 20 years can be appreciated by the fact that in the available literature only 18 reports were found.

The age incidence in our combined series is as follows: aged 12 years, 1; 15 years, 1; 18 years, 1; 21 years, 2; 22 years, 2; 23 years, 6; 24 years, 1; 25 years, 8; 26 years, 9; 27 years, 9; 28 years, 14; 29 years, 19. The ages noted were those given on the charts at the time patients were admitted to the hospital for treatment; although from the histories it was evident that the disease had started earlier. If age 30 had been included, the

TABLE II.—DEATHS FROM BREAST CANCER IN PATIENTS LESS THAN 30 YEARS OF AGE

Age	Population	Deaths	Rate per 100,000	Per cent of all cancer
0 to 4	10,833,222	2	0.02	0.02
5 to 14	23,347,523	3	0.01	0.03
15 to 24	21,235,387	21	0.10	0.20
25 to 34	18,017,199	290	1.61	2.68

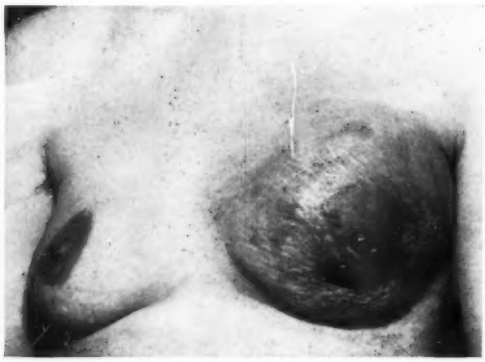

Fig. 1. No. 91201. Rapidly growing diffuse duct cancer complicating lactation, of 4 months' duration. Enlargement of the breast was noted in the 26 year old woman 1 month after childbirth. Patient died of general metastases after 7 months of illness.

number of cases would have been increased by 30 per cent.

Whereas in this group more than one-half applied for surgical consultation in our general series of cases of cancer of the breast (Eggers, de Cholnoky, and Jessup), only one-third applied for surgical consultation within the first 6 months. This may indicate more alertness in young women, or results of public education.

SYMPTOMATOLOGY

Chief complaint was the same as in adult cases —the discovery of a "painless lump."

Clinical examination in the early cases did not reveal signs of malignant neoplasm. Frequently the tumor was freely movable (10 per cent) and a diagnosis of fibroadenoma was made; it was only by means of frozen section at operation or by routine pathological examinations that the diagnosis was established.

When the tumor was hard, its border ill defined, and there was some fixation to surrounding tissues cancer was suspected.

Early diagnosis and treatment may be facilitated if the surgeon's policy is to remove all solid tumors regardless of signs of cancer and to proceed with the radical operation if the findings are substantiated by microscopic examination.

Fixation to the overlying skin, dimpling and retraction of the nipple, with elevation and deformity of the breast, as well as axillary lymph node involvement, are signs of advanced malignant tumor.

Careful examination in the sitting as well as in the lying position should be done with the arm in different positions, to facilitate palpation. Inasmuch as the majority of breast tumors are situated in the outer upper quadrants their detection and study of detail is favored when the patient is placed on the normal side and the suspected breast allowed to drop over to that side. When the examining palm is pressed against the chest wall and the breast is gently palpated, a growth becomes more prominent, may even become visible, and the dimpling of the skin is more evident.

DIFFERENTIAL DIAGNOSIS

In young women inflammatory lesions are observed most frequently, especially in connection with nursing. Some intraglandular abscesses with infiltration may simulate cancer; but tenderness, edema, and the course of the inflammatory process aid in differentiation.

Tuberculosis of the breast may simulate cancer, especially if there is axillary lymph node involvement. The softer consistency of the axillary lesion, which has the tendency to adhere early to the skin to form a fistula favors the diagnosis of tuberculosis rather than cancer. A pathological examination will be conclusive. X-ray films may show the origin of the tuberculous lesion in the chest.

Syphilis and actinomycosis are rare conditions but are occasionally encountered in the breast.

We pointed out in previous papers (9, 10) that fibroadenoma predominates in females and males under 30 years of age. In the male the fibroadenoma is a diffuse nonencapsulated lesion, and may be mistaken for cancer (10). Multiple tumors suggest benign lesions, such as fibroadenomas or cystic disease of the breast, but do not necessarily exclude the possibility of the presence of a cancerous nodule. Paraffinoma of the breast may be mistaken for cancer (11). Any hard, firm nodule especially affixed to the surrounding tissue, calls for excision and pathological examination.

SITE

In our series, cancer occurred more often in the right breast. In both breasts, the tumor seems to have been more frequently observed at the outer upper quadrants.

SIZE OF TUMOR AND AXILLARY LYMPH NODE INVOLVEMENT

The size of the tumor varied from 0.5 to 17 centimeters in diameter. Among 31 lesions there were 8 small tumors (up to 2 cm. in diameter), 11 medium sized ones (2 to 4 cm. in diameter), and 12 large ones (4 cm. and over).

TABLE III.—RESULTS*

Hospital	Total	Inoperable	Operated Upon					
			Less than 5 years		More than 5 years		More than 10 years	
			Alive	Dead	Alive	Dead	Alive	Dead
Skin and Cancer Unit Post Graduate 1924–1940	17	6	4		3	4	1	1
Lenox Hill 1924–1940	11	1			4	6	1	
New York 1932–1940	6		2		1	3		
Roosevelt 1910–1940	18	2	1		5	10	3	5
Pondville Memorial and Massachusetts General 1922–1940	21	5	3		7†	6	1	4
Total	73	14‡	10		20	29	6	10
					49		16	
Per cent					40.8		37	

*Drs. William De W. Andrus, Walter W. Brandes, William A. Cooper, Henry W. Cave, Carl Eggers, Thomas H. Russell, Grantley W. Taylor, and William C. White were most kind in facilitating the review of the material from the hospitals with which they are connected. Miss Elizabeth Carr, librarian of the New York Post Graduate Hospital, and P. R. Eastman, of the Metropolitan Life Insurance Company, furnished the statistical data.

†One alive with disease after supraclavicular node dissection.

‡Including 3 recurrences after insufficient operation performed elsewhere.

It is interesting to note that only 1 instance of axillary lymph node involvement was found among patients with small tumors. On the other hand, in patients with tumors over 3 centimeters in diameter in whom radical operation was performed, axillary lymph node involvement was demonstrated in 90 per cent. This corresponds with observations made in adult cases (12).

Seven of the 8 patients with small tumors survived the 5 year period.

Of 11 patients with cancer of the breast without lymph node involvement, operation resulted in 5 year arrest in 10 cases (90 per cent with 1 death); while only 5 of 25 cases with lymph node involvement survived the 5 year period (20 per cent), with 20 deaths.

Lymph node involvement was found in 58.5 per cent, which is somewhat better than the 63.7 per cent found among our general series of cancer of the breast (12). This observation corroborates Harrington's findings, who reported axillary involvement in only 48.5 per cent, contrasting with 61.6 per cent in the older groups.

PATHOLOGY

In 45 of the cases, grading of the tumor was obtained. In 8 cases the tumors were found to be grade 3 or grade 4. All of these patients, showing a very active growth, died within 1 year after operation, except 1 who is still alive after 5 years on whom radical operation was performed.

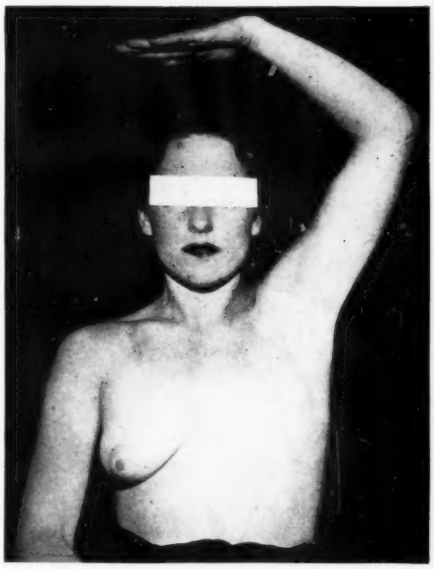

Fig. 2. M. J., 26 years of age. A typical postoperative result 4 years after radical amputation of the breast for cancer. No swelling of the arm and good functional result.

The following pathological diagnoses were noted: 2 grade 1 adenocarcinoma; 1 papillary cystadenocarcinoma (with axillary involvement and inoperable); 16 adenocarcinoma grade 2; 4 colloid carcinoma; 2 medullary carcinoma; 3 carcinoma arising in fibroadenoma; 1 solid carcinoma; and 2 inflammatory carcinoma. In 11 the only diagnosis was carcinoma of the breast.

Among those surviving the 5 year period the diagnoses were: 5 adenocarcinoma; 1 duct carcinoma; 1 colloid carcinoma; 2 medullary carcinoma; 2 carcinoma in fibroadenoma. In the remainder the carcinoma was not classified. There was 1 male of 25 with colloid carcinoma who died within 2 years. A bilateral colloid carcinoma in a 22 year old woman ended fatally within a year.

In this younger age group late metastasis may be observed, as in the general group. Pulmonary metastasis was noted in a 21 year old girl, 5 years after removal of the breast for cancer, indicating late permeation of the lung (Boyd). One of our patients, a 28 year old woman, died 7 years after a radical operation had been performed, with general metastasis.

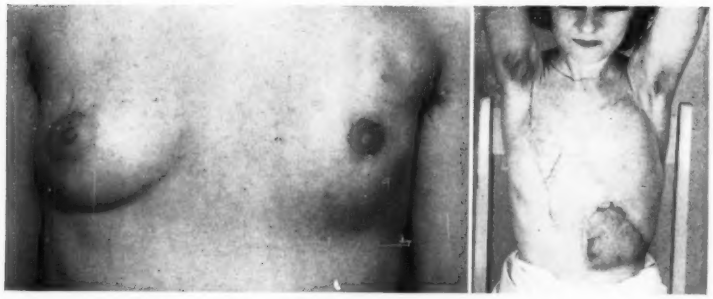

Fig. 3. A. A. No. D6870, 22 years of age. Bilateral cancer of breast. Extensive involvement of left breast with skin metastasis necessitating wide excision and plastic repair by an abdominal skin flap and skin grafting on the right. Good functional result. Fatal outcome after 1½ years. No local recurrence.

Cancer of the breast in a girl of 17 was observed in an accessory breast (Heitzmann). This is a rare occurrence, but it may be that such a tumor develops in the prolongation of the glandular element with direct connection with the main breast tissue (8). There were no patients with a bleeding or discharging nipple and there were no patients with Paget's disease in this series.

TREATMENT

We believe that punch biopsy is unsatisfactory and dangerous in inexperienced hands. If operation is performed for biopsy purpose, the whole tumor should be excised for examination. Once the diagnosis of cancer is definitely established radical operation should be performed with careful and thorough axillary lymph node dissection, as described in a previous paper (12).

In 3 cases in this series, extensive operations were performed to give relief to the patient. One 22 year old girl had a bilateral advanced cancer. We gained the impression that in spite of painstaking radical operations, life could not be prolonged materially.

There were 13 (17 per cent) inoperable cases. Five of them were recurrent lesions, with distant internal metastasis, in patients who had undergone previous excision or simple mastectomy. In these patients no operation was performed for palliation. There were 2 cases of inflammatory malignant tumor at the age of 26, with rapid fatal outcome.

No definite improvement was noted following x-ray therapy, which however may be tried in patients with rapid growths.

RESULTS

A detailed analysis of Table III shows the number of cases and the results at the different hospitals. Cases lost or not followed up (18) were classified as "died from disease." There was no operative mortality.

Of the 73 collected cases, 14 (19 per cent) were inoperable at the time of admission. Forty-nine were operated upon more than 5 years previous to this study. Of these, 20 were alive, constituting a 40.8 per cent 5 year arrest. Of 16 patients operated upon 10 years previously, 6 were alive, a 37 per cent 10 year arrest.

These figures in this small group indicate that in young women late recurrences are less frequently observed.

BILATERAL CANCER

Cancer in both breasts may be noted simultaneously (19), or the malignant neoplasm may appear in the second breast after an interval of months or years.

Bilateral cancer developed in 5 per cent of our series, which corresponds to the findings in our general series (12). One of these patients lived over 5 years.

A brief outline of their histories follows:

CASE 1. A. A., a 22 year old married woman, came to our clinic with a diffuse advanced cancer of the breast with axillary, supraclavicular, and skin metastasis (Fig. 3). She stated that in another hospital she had had a consultation 5 months previously and received "injections." Information was obtained that the patient was treated by theelin injections for a diffuse mazoplasia. It seems that early diagnosis was not made; or that the administration of estrogenic substances may have had some influence in the development of a cancer. In spite of radical operation, consisting of removal of the right breast with plastic repair, 3 months later the removal of the left breast and axillary-supraclavicular lymph nodes, the patient died with general metastasis in 10 months.

CASE 2. A 23 year old girl had had a radical operation for cancer of left breast with axillary lymph node involvement, by Dr. Robert H. Kennedy. Five years later patient had been delivered of a normal child, and a year after that

cancer was found in the other breast. A radical operation was performed by Dr. Richard Kessler. A therapeutic abortion was performed within a year. Two years later a local recurrence was excised in the right axilla. This patient is now alive, 11 years after the first operation, completing the 5 year survival period after the second breast operation (Fig. 4).

CASE 3. A 29 year old woman, in whom both axillae were extensively involved, came for treatment. She gave the history that 3 years previously both breasts had been removed for "benign tumors" and no lymph nodes were dissected.

CASE 4. A 28 year old patient died 9 months after bilateral radical mastectomy (performed within 2 months) for an advanced grade 3 cancer. This patient was one of 7 children, 4 of whom have, so far, had cancer.

PREGNANCY AND LACTATION

Four of this series living over 5 years, gave the history of pregnancy. Three were delivered of a normal child before or after the radical operations and nursed their babies for 3 to 6 months. One had insufficient milk from the breast. One of our patients is alive 11 years and 5 years, respectively, after bilateral radical operation (Fig. 4). She had 1 child between the 2 radical operations and had an abortion after the second breast was removed.

This observation is insufficient for any conclusion, and the reader is referred to Harrington's (16) remarkable work on the subject. From his observation the prognosis appears to be unfavorable if the malignant neoplasm develops during the childbearing period and there is axillary lymph node involvement, but a high survival rate was found with early radical operation, especially when the cancer was not of high grade and no axillary lymph node metastasis was found.

It is gratifying to know that if pregnancy occurs after radical operation, young women may deliver healthy children and because of childbearing may not develop generalized metastases. If the tumor is a small early growth, without lymph node involvement, and f patient remains well for about 3 to 5 years, one may permit pregnancy. But with advanced growth and axillary involvement the prognosis is known to be poor; in such cases recurrence and distant metastasis are common, and birth control should therefore be considered.

ANALYSIS OF STUDY

This study reveals that cancer in the young occurs more frequently than previously thought. Unfortunately the early lesions are frequently not diagnosed because malignant tumor is not suspected and physical signs are not convincing. Thus, the safe way to avoid errors is to remove all solid tumors of the breast, for the danger is that the harmless fibrous tumor may be malignant.

Fig. 4. F. D. No. J38247. Result after bilateral radical operation for cancer of the breasts. Left breast was amputated 11 years ago at the age of 23 years, by Dr. Robert H. Kennedy. Axillary lymph nodes were found involved by cancer. Right breast was amputated 5 years ago, by Dr. Richard Kessler. Local recurrence in the right axilla was removed 3 years ago. Patient has no evidence of local or general metastasis at the time of writing.

One of our patients, a 27 year old girl had been advised by 3 physicians not to worry, about a small "lump" and had been given x-ray therapy to dissolve the growth. When she applied for treatment she had a far advanced cancer of the breast. Such a conservative attitude is not a unique observation and it may account for the pessimistic prognosis previously held. The number of inoperable cases (17 per cent) is extremely high, and may be the result of neglect or inadequate surgery, or even massage of the lumps which may have promoted internal metastasis. In case of multiple solid tumors, the removal and examination of one does not assure diagnosis; for one of the tumors remaining may be malignant, as it was found to be true in a previously reported case (9).

Painstaking radical operation prolongs life or saves patients with axillary involvement, and the local recurrence rate is very low.

SUMMARY

This study is based on 73 cases of mammary cancer in patients under 30 years of age, collected from the records of 6 hospitals; the careful follow-up records, it is thought, make this study more valuable. Cancer of the breast in patients under 30 years of age accounts for 2 per cent of all mammary cancers. Early diagnosis can be made with certainty only in the laboratory. In small

tumors less than 2 centimeters in diameter, lymph nodes are infrequently involved and the prognosis is favorable.

Five year survivals in the patients operated upon were found to be 40.8 per cent; 10 year survivals, 37 per cent.

The conclusion is reached that the results of radical surgery in young women under 30 years of age are comparable to those obtained in the more advanced age groups. The previously held belief that the prognosis for women under 30 years of age who have malignant tumors of the breast is fatal seems untenable.

REFERENCES

1. Blodgett, A. N. Boston M. & S. J. 1897, 136: 611.
2. Bogen, E. Am. J. Pub. Health, 1935, 25: 245–250.
3. Boyd, William. Surgical Pathology. 4th ed. Philadelphia: W. B. Saunders, 1938.
4. Bryant, R. C. Surg. Gyn. Obst., 1914, 18: 545–546.
5. Carnett, J. B., Widmann, B. P., and Howell, J. C. Surg. Clin. N. America, 1932, 12: 1363.
6. Chauvel and Renaud, M. Bull. Soc. anat. Paris, 1921, 91: 245.
7. Cooper, B. B. Lectures on the Principles and Practice of Surgery. London: J. Churchill, 1851.
8. de Cholnoky, Tibor. Arch. Surg., 1939, 39: 926–941.
9. Ibid., 1939, 38: 79–98.
10. Idem. Am. J. Surg., 1935, 30: 298–304.
11. Ibid., 1939, 44: 649–653.
12. Eggers, Carl, de Cholnoky, Tibor, and Jessup, D. S. D. Ann. Surg., 1941, 113: 321–340.
13. Ewing, J. Neoplastic Diseases. 4th ed. Philadelphia: W. B. Saunders, 1940.
14. Fowler, R. H. Med. Rec., N.Y., 1915, 87: 730–732.
15. Harrington, S. W. Pennsylvania M. J., 1940, 43: 413–427.
16. Idem. Tr. Am. Surg. Ass. 1937, 55: 209–219.
17. Heitzmann, C. Med. Rec., 1888, 34: 21.
18. Kaufmann, E. Pathology. Philadelphia: Blakiston, 1929. Vol. 3.
19. Krauss, L. W., and Kline, B. S. Am. J. Surg., 1926, 1: 277.
20. Levings, A. H. Am. J. Surg., 1917, 31: 29–32.
21. Luttinger, P. Cancer, 1924, 2: 27–33.
22. Nunn, L. L. Northwest M., 1937, 36: 301.
23. Sears, J. B., and Schlesinger, M. J. N. England J. M., 1940, 223: 760.
24. Taylor, G. W. Personal communication.
25. Thompson, W. H. Brit. M. J., 1908, 2: 502.
26. Winslow, R. Ann. Surg., 1921, 74: 341–346.

THE EVOLUTION OF THE CIRCULATION IN THE DEVELOPING FEMORAL HEAD AND NECK

An Anatomic Study

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THREE years ago a report was made of a study of the circulation in the adult femoral head and neck. The most significant observations made at that time may be briefly stated as follows:

1. The ligamentum teres carries at least one main artery which penetrates the head of the femur and anastomoses with vessels entering the head by way of the visceral capsule in approximately 80 per cent of the specimens successfully injected, even in those of the most advanced age.

2. In approximately 20 per cent of the adult specimens in which the ligamentum teres arteries were successfully injected, the vessels failed entirely to enter the femoral head. In these instances the opaque material could be seen to course through the arteries of the ligament to the fovea area where it was then returned through the veins of the ligament away from that area.

3. The uniformity of size and area of distribution of the vessels within the femoral head led to the conclusion that it was adequate to nourish a greater portion of the head of the femur in all cases in which the artery actually penetrated the substance of the head.

4. It was likewise noted that the visceral capsule never failed to carry two groups of arteries, usually three to four in number, which uniformly entered the neck of the femur just distal to the subcapital area. Immediately after entering the neck of the femur these vessels change their course at a 45 degree angle and travel directly toward the center of the femoral head where they anastomose freely with the terminal branches of the nutrient artery of the shaft and the ligamentum teres vessels, sending their terminal branches to the subcondylar area about the circumference of the head. These two capsular artery groups lie within the superior posterior quadrant and inferior posterior quadrant of the visceral capsule, which is loosely attached to the neck of the femur. No arteries of importance were found within the anterior portion of the visceral capsule. These capsular arteries which were found to be the never failing and major source of blood going to the head and neck of the femur, arise from the medial circumflex artery, a branch of the femoral profunda, which lies close to the bone in the intertrochanteric line behind.

5. It was likewise found that a small branch from the posterior circumflex artery joins with a branch of the obturator just distal to the cotyloid notch to make up the blood vessel which passes under the annular ligament and sends one of its terminal branches into the ligamentum teres, the other passing on to supply the pulvinar fat pad in the floor of the acetabulum.

6. Finally, we were interested to observe that we always failed, both by injection of opaque material and serial sections, to demonstrate blood vessels entering the substance of the femoral head by way of the ligamentum teres in specimens from infants and children under approximately 10 years of age. It was this last significant observation which prompted a further study of the literature and investigations concerning the circulation in the developing femoral head in the preadolescent age group which furnishes the material upon which this report is founded.

As a result of an exhaustive review of the literature available on this subject, one seems justified in saying that such a study tends to confuse rather than clarify our thinking. Obviously a better knowledge of the circulation as it develops in the femoral head and neck of the growing child would be expected to add to our understanding of the sequelae of events associated with certain of those conditions which are frequently seen affecting the hip joints of children and which are so difficult to explain in the light of present knowledge.

REVIEW OF LITERATURE

Hyrtle, as early as 1846, announced that he had shown by injection that the ligamentum teres vessels in children failed to enter the spongy bone but anastomosed through capillaries with the venous system without entering the femoral head.

Since that time, and even before, opinions of different authors on the importance of these vessels for the nutrition of the growing femoral head have been very controversial and discrepant.

Fig. A.

Fig. 1.

Fig. 2.

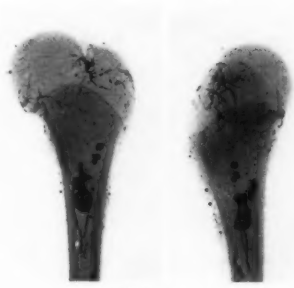

Fig. 3.

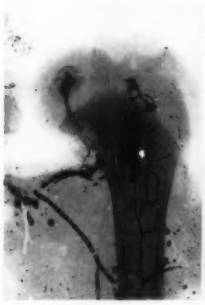

Fig. 4.

Fig. 4a.

Fig. 5.

Fig. 6.

Fig. A. Femur of a 5 weeks old pup. Injected capsular arteries of the femoral neck demonstrated as being distributed to the ossifying center of the developing head of the femur.

Fig. 1. The femur of an 8 month old fetus was injected by way of the nutrient artery of the shaft only. The injected material has found its way into the capsular arteries shown at the base of the neck of the femur. This specimen demonstrates the presence of an anastomosis between the nutrient and capsular arteries being established even before birth.

Fig. 2. The medial circumflex artery only was injected in a specimen of an infant only 6 weeks old, demonstrating an early penetration of the capsular arteries into the cartilaginous head of the femur.

Fig. 3. Specimen from a 6 weeks old infant. Injections of the medial circumflex ligamentum teres and nutrient vessels were made. Although none of the injections was entirely satisfactory, the opaque material in small amounts reached the capsular arteries which are clearly demonstrated to be entering the substance of the head of the femur, one branch penetrating nearly to the nuclear area of the head.

Fig. 4. Femur from an infant 14 months of age. The medial circumflex artery was first injected. The inferior capsular arteries can be seen to penetrate into the osseous center and developing head of the femur.

Fig. 4a. The lateral view of Figure 4 demonstrates the extent to which the capsular arteries supply the growing center of the femoral head at 14 months of age.

Fig. 5. From the femur of a boy 2 years old. Nutrient artery of shaft only injected. The anastomosis of nutrient artery of the shaft and capsular arteries of femoral neck is shown. Capsular arteries of the neck not injected directly.

Fig. 6. Specimen from an infant 16 months of age. The capsular arteries were first directly injected where they branch from the medial circumflex artery. Later the nutrient artery of the shaft was successfully injected but we failed in an attempt to inject the ligamentum teres artery. This injected specimen demonstrates very clearly and positively the patterns of distribution of the arteries which contribute blood to the nuclear ossifying center of the head and neck of the femur as early as 16 months of age. It is apparent that the very small arteries which travel the length of the ligamentum teres supply nourishment to the fovea and a shallow adjacent area of the head of the femur. This specimen also seems to present convincing evidence that no end branches of the nutrient arteries penetrate the epiphyseal plate area at 16 months of age.

Palletta in 1820 and Sappey in 1844 thought the vessels of the round ligament played an important part in the nutrition of the developing femoral head. Hesse was of the opinion that vessels of the round ligament, in case of a detachment of the head, were able not only to maintain the normal nutrition of the nucleus of ossification of the head of the femur but also, by forming a granulation tissue to vascularize the joint cartilage. Nussbaum injected opaque dyes into the round ligament vessels and always found them entering the head of the femur.

Kolodny, also by the injection method, reported he was able to demonstrate that the central region

Fig. 7.

Fig. 7a.

Fig. 8.

Fig. 8a.

Fig. 7. The specimen is from the femur of a boy 7 years of age. The injections were made successively in the nutrient artery of the shaft, both the superior and inferior capsular arteries, and the ligamentum teres arteries. The injected specimen submitted shows a very extensive blood supply already established throughout the head and neck of the femur. Also the capsular arteries are demonstrated to be the most direct and important source of nourishment to the ossifying center in the head of the femur. Fine end arteries or terminal branches of these arteries can be seen to penetrate to the very periphery of the expanding ossifying portion of the femoral head. Some of these minute vessels have given way under the pressure exerted on the opaque fluid, during injection, as can be seen by the collection of lakes of the material in the subcondylar area about the periphery of the head of the femur. Also in this lateral view, one notices a few end artery branches of the injected nutrient artery passing through thinned out portions of the dome of the epiphyseal plate.

Fig. 7a. Lateral view of the same specimen as in Figure 7. Here we see again the tremendous fine network of arteries distributed to all portions of the femoral head as the ossifying center expands. However, the significant fact to be noted is that in this view contact has not been made between the capsular arteries and those of the ligamentum teres.

Fig. 8. Specimen from a 10 year old girl. Ligamentum teres and nutrient artery injection. Branches from nutrient vessels seem to penetrate the epiphyseal plate and terminate in the ossifying nucleus. The material injected by way of the ligamentum teres vessels failed to enter the head.

of the femoral head was directly entered by vessels of the round ligament after they had penetrated the head at the fovea capitalis. Mazzarella reported that the head of the femur in the newborn was nourished by the artery of the round ligament as well as branches from the capsular arteries after the second year of life, the time of establishment of the epiphyseal cartilage and appearance of the center of ossification in the femoral head. He also agreed with Lexer and Langer that the head is also supplied with blood from anterior branches from the neck which pass through the epiphyseal cartilage, but these last vessels are of little importance in his opinion. Schmorl expressed the idea that as early as the second year of life, the ligamentum teres vessels begin to obliterate by proliferation and swelling and atrophy of parts of the vessel wall. This was regarded by him as physiologic obliteration; inactivity atrophy. It was also his belief that from the second year until the third decade of life there was no great change in the condition of the ligamentum teres. After the third decade of life, the lumen of the vessels becomes narrow, showing only a narrow slit or one entirely impermeable. These processes were thought by him to be physiologic involution after the end of the growing period. After the fifth decade of life the changes of the vessels are usually pathologic. There is, therefore, a continuous decrease of blood flowing to the head of the femur after the second year of life, until changes in the ligamentum teres make the blood circulation impossible. It is obvious then that Schmorl is of the opinion that the ligamentum teres vessels are of importance in nourishing the growing head of the femur before the second year of life.

Luschka in 1865 stated that he never failed to find arteries which made their way through pores of the fovea capitalis into the substance of the head of the femur. Logroscino, after injecting dyes into the round ligament arteries, found good development and distribution of the branches of these arteries in a triangular district in both youths and adults. Elgart compared the round ligament to the umbilical cord whose vessels obliterate after losing their function. Devermann, Langer, Eggers, Cooper, Bonnet, Moser, Hildebrand, and Anschuetz are other authors who attribute importance for the nutrition of the head

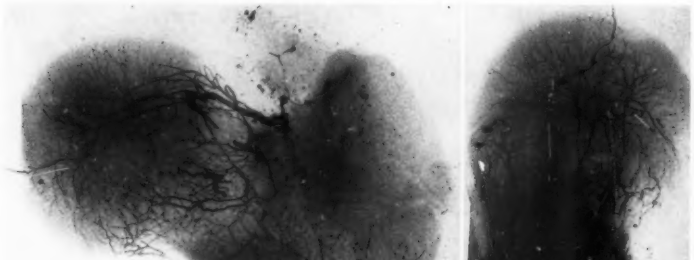

Fig. 9. Specimen from a 15 year old boy. The only vessels injected were the capsular arteries at the base of the femoral neck. During the injection, the opaque material could be seen to drop out through the ligamentum teres vessels, demonstrating completion of the anastomosis between the ligamentum teres, the capsular and nutrient vessels. All portions of the shaft, neck and head of the femur are seen to be well supplied with blood vessels.

of the femur only to the round ligament vessels of juvenile individuals; they have only a secondary and undetermined importance after termination of bone growth in the head of the femur.

Zemansky apparently accepted the opinions of the authors mentioned, for he stated, "Thus, anatomical studies have definitely established that, in the adolescent, the femoral head is nourished by the round ligament vessels." He subsequently did a series of arterial injections, using rabbits, according to the method of Gross, demonstrating to his own satisfaction that the vascular arrangement was not dissimilar to that of the human femur at a corresponding age. After injecting a series of rabbits of different age groups, he concluded that "the blood supply from the ligamentum teres vessels to the femoral head gradually diminishes and ceases completely when the epiphysis unites with the shaft. It cannot be stated with certainty that the round ligament vessels of the human cease to furnish blood to the femur at the same relative developmental stage. However, inasmuch as all anatomical evidence indicates that these vessels usually are completely closed in human adult life, it is most likely that a similar condition exists."

Chandler after studying serial sections of femoral head and ligamentum teres in 20 fetal specimens, 7 months to term, reported that vessels are present long before the seventh month. As soon as the vessels of the round ligament enter the head they branch and continue to penetrate into the substance of the bone. He further stated that a union is present between the vessels of the round ligament and the capsule or metaphyseal arteries in adult life, but such union has not occurred in the specimens available for his study. He failed to express an opinion as to when anastomes of these two systems took place beyond saying such union probably occurs some time after birth. Thus, we have an extensive group of investigators who believe that the ligamentum teres vessels uniformly enter the substance of the head of the femur in infants and growing children and are its chief, if not its only, source of blood supply during all or a major portion of the growth period.

VISCERAL CAPSULAR VESSELS

A second group of investigators, after anatomical studies, are of the opinion that the capsular arteries entering the femoral neck near the epiphyseal plate, not the ligamentum teres vessels, are the true source of nourishment to the growing femoral head. As previously mentioned, Hyrtle observed vessels in the round ligament, but concluded that they anastomosed with veins at the junction of the ligament with the head and then passed back through the ligament. He further

stated it was his opinion that the epiphyseal nucleus in the femoral head of growing children received its blood supply from the capsular vessels of the neck. Walmsley in 1915 studied the ligamentum teres in cross section by aid of a hand lens and also by injection methods. He reported that "the ligamentum teres does not convey blood into the head of the femur. Most of the foramina in the fovea capitalis are channels of communication of the ligamentous tissue into the cartilage of the fovea and osseous substance of the bone, not vascular openings." Chandler in 1936 reported as his opinion that the "head of the femur, before fusion of the epiphyses, received its blood supply through the branches of the cervical vessels which lie in the folds of reflected synovia along the femoral neck and from the vessels of the ligamentum teres. After fusion of the epiphysis at the conclusion of growth, small vessels of the femoral neck anastomose with those of the femoral head."

ANIMAL EXPERIMENTATION

Several investigators have done animal experiments using cats, dogs and rabbits to conduct studies of the effect produced on growing femoral heads by interrupting the various blood supplies to the upper end of the femur. In this group the work of Cella in 1936 is especially interesting. He used cats, dogs, and rabbits of different ages. In the first group resections of the round ligaments were done at one day of age, before the formation of the nucleus of ossification. The specimens were recovered after the growth period. In this group there were no microscopic changes in the head of the femur. Microscopically, there was a small zone, corresponding to the insertion of the round ligament, having poor staining ability; the cells with small nuclei. The center of ossification appeared always normal. The second group of animals operated upon 10 days after birth produced the same macroscopic and microscopic changes as were observed in the first group, but they were more pronounced. There was produced an ischemic triangular zone with the base at the implantation of the round ligament, reaching down to the center of ossification. The cells in this area contained small nuclei and granulous protoplasm. The nucleus of ossification appeared normal always and did not show any defect of osteogenesis. In the third group of 40 day old animals at 5 months and in old animals, no macroscopic or microscopic changes followed division of the ligamentum teres. The conclusions as stated by Cella are:

1. The round ligament carries vessels which contribute to, but are not indispensable for, the development of the osseous district which corresponds to the implantation of the round ligament. They play a rôle only in the young animals (rabbits and cats) previous to the formation of the nucleus of ossification, especially during the first moments of its formation.

2. The importance of these vessels diminished rapidly with increasing age of the animals and even immediately after the formation of the center of ossification there occurs no change in the head of the femur after elimination of these vessels, except in a small zone around the implantation of the round ligament.

3. The nucleus of ossification of the head of the femur obtains its blood supply from branches of the posterior circumflex artery. The vessels of the round ligament have no importance whatsoever in its nutrition. Our own experience in experimental work on young dogs is identical with that of Cella. After the division of the ligamentum teres, the femoral heads reclaimed at the end of 30 and 60 days showed no change when compared with the control head, except for a slight depression of flattening about the insertion of the ligamentum teres. We were also able to prove to our own satisfaction that the capsular arteries, even at the 5th week, send very definite vessels into the ossifying center. The circulation pattern of these vessels was easily demonstrated by the injection method (Fig. A). Obviously these findings offer a logical explanation of the absence of changes in the ossifying center following the division of ligamentum teres in experimental animals.

Iselin who conducted similar experiments on young dogs, and Bergmann who worked on young rabbits, reported like findings. Stewart, after extensive investigations on young dogs, reported "no marked changes occurred in the animals in which the ligamentum teres alone was cut."

In view of the fact that uniformly when the ligamentum teres in young animals is divided, no gross changes occur in the ossified center of the head of the femur, we believed we were justified in taking sides in this controversy with those who were of the opinion that the capsular vessels, not the ligamentum teres vessels, furnish nourishment to the growth center in the head of the femur. To add further proof that such was the case, we decided to make an attempt, by the injection method, to demonstrate the circulation pattern of the capsular and nutrient arteries at various age levels, beginning with fetal life and carrying on into the adolescent years when we were quite certain that these circulations

finally broke through and established an anastomosis with the round ligament vessels. Fresh autopsy material was secured and the vessels were immediately injected with opaque material under twelve power binoculars. We used a specially constructed thirty gauge needle and a one cubic centimeter syringe. X-ray films were taken to demonstrate the course of the blood vessels. A group of specimens have been selected from the accumulated material varying as to age groups from the 8th month of fetal life to 15 years of age. This material is now presented in the hope we will be able to show satisfactory evidence that:

1. The nutrient artery of the shaft establishes communication and definitely anastomoses with the capsular arteries very early, even in fetal life.

2. The capsular arteries very early in life push several sizeable blood vessels through the cartilage at the junction of the head and neck, which vessels, however, go around the epiphyseal line, by-passing that cartilage, so to speak, and as soon as they enter the cartilaginous substance of the femoral head, angulate at 45 degrees and travel directly to the ossifying center. Doubtless both the posterior superior and posterior inferior capsular arteries send branches to the growth center. However, we have not been able to demonstrate both as contributors in every instance.

3. The capsular arteries are the only essential source of blood supply to the ossifying center in the head of the femur. We failed in all our attempts to demonstrate injected material entering the substance of the head of the femur in infants and children by way of the ligamentum teres vessels, although we were able successfully to force the opaque material through these vessels to the fovea.

4. The anastomosis between the capsular arteries and the ligamentum teres vessels does not take place until the ossifying center of the head is expanded to the point where only thin articular cartilage separates the capsular and ligamentum teres vessels at the fovea. As the cartilage in this area thins out, the contact between these two systems occurs and anastomosis is accomplished, perhaps at approximately the 12th to 14th year of life. Failure for any reason to establish this anastomosis accounts for the 20 per cent of adults in whom the ligamentum teres vessels fail to enter the head.

DEMONSTRATION OF INJECTED SPECIMENS

In Figure 1 is presented the femur of an 8 month old fetus which was injected by way of the nutrient artery of the shaft only. It is seen that the injected material has found its way into the capsular arteries shown at the base of the neck of the femur. This specimen demonstrates the fact that an anastomosis is present between the nutrient and capsular arteries and was established even before birth.

In Figure 2, a specimen of an infant only 6 weeks old, the medial circumflex artery only was injected. This specimen demonstrates an early penetration of the capsular arteries into the cartilaginous head of the femur.

Figure 3 is a specimen taken from a 6 weeks old infant. Injections of the medial circumflex ligamentum teres and nutrient vessels were made. Although none of the injections were entirely satisfactory, the opaque material in small amounts reached the capsular arteries and they are clearly demonstrated to be entering the substance of the head of the femur; in fact, one branch penetrates nearly to the nuclear area of the head.

Figure 4 is a femur taken from an infant 14 months of age. In this case the medial circumflex artery was first injected. The inferior capsular arteries can be seen to penetrate into the osseous center and the developing head of the femur.

Figure 4a is a lateral view of Figure 4 and demonstrates the extent to which the capsular arteries supply the growing center of the femoral head at 14 months of age. The nutrient artery was later injected in this same specimen. The injected material filled innumerable end arteries proximal to the epiphysial line.

Figure 5 shows the femur of a boy 2 years old. In this case the nutrient artery of shaft only was injected. The anastomosis between the nutrient artery of the shaft and capsular arteries of femoral neck is shown. In this instance the capsular arteries of the neck were not injected directly.

Figure 6 is a specimen from an infant 16 months of age. The capsular arteries were first directly injected at a point where they branch from the medial circumflex artery. In this injected specimen is demonstrated very clearly and positively the patterns of distribution of the arteries which contribute blood to the nuclear ossifying center of the head and neck of the femur as early as the age of 16 months. It is apparent that the very small arteries which travel the length of the ligamentum teres supply nourishment to the fovea and a shallow adjacent area of the head of the femur. It is also evident from this specimen that no end branches of the nutrient arteries penetrate the epiphyseal plate area at 16 months of age.

In Figure 7 is presented the specimen from the femur of a boy 7 years of age. In this case the injections were made successively in the nutrient

artery of the shaft, both the superior and inferior capsular arteries and the ligamentum teres arteries. This injected specimen shows that a very extensive blood supply has already been established throughout the head and neck of the femur. Also the capsular arteries are demonstrated to be the most direct and important source of nourishment to the ossifying center in the head of the femur. Fine end arteries or terminal branches of these arteries can be seen to penetrate to the very periphery of the expanding ossifying portion of the femoral head. Some of these minute vessels have given way under the pressure exerted on the opaque fluid, during injection, as can be seen by the collection of lakes of the material in the subcondylar area about the periphery of the head of the femur. In this lateral view, one also notices a few end artery branches of the injected nutrient artery passing through thinned out portions of the dome of the epiphyseal plate. Apparently, then a few of these arteries pierce the substance of the plate as it thins out and play a minor rôle in nourishing the head, later forming an anastomosis with the capsular arteries in this area. Attention is particularly called to the apparent contact between the ligamentum teres vessels and those of the capsular arteries in the ossifying head. (See lateral view of same specimen Figure 7a.)

Figure 7a is a lateral view of the same specimen as in Figure 7. Here again is shown the tremendous fine network of arteries distributed to all portions of the femoral head as the ossifying center expands. However, the significant fact to be noted is that in this view contact has not been made between the capsular arteries and those of the ligamentum teres.

This contact or anastomosis will, undoubtedly, take place as soon as the ossification in the head has extended or expanded to the subfoveal area through the base of which fine terminal branches of the ligamentum teres penetrate for a very short distance during infancy and childhood.

Figure 8 is a specimen from a 10 year old girl. In this case the ligamentum teres and nutrient arteries were injected. Branches from nutrient vessels seem to penetrate the epiphyseal plate and terminate in the ossifying nucleus. The material which was injected by way of the ligamentum teres vessels has failed to enter the head.

Figure 9 is a specimen from a 15 year old boy. The only vessels injected in this instance were the capsular arteries at the base of the femoral neck. During the injection, the opaque material could be seen to drop out through the ligamentum teres vessels, a fact demonstrating the completion of the anastomosis between the ligamentum teres, the capsular and nutrient vessels.

In this specimen it is also seen that all portions of the shaft, neck and head of the femur are seen to be well supplied with blood vessels. It is apparent that a considerable time before the age of 15 there had been contact established between the blood vessels of the ligamentum teres and the capsular arteries. Also fine branches of these arteries communicate with those of the nutrient artery of the shaft, for although the only injection made was into the capsular arteries as they left the medial circumflex vessel at the base of the neck of the femur, the opaque material penetrated through those vessels and into their anastomosis with those of the nutrient artery in the shaft of the femur.

This specimen likewise disproves the existence of a so called "silent area of nourishment" in the head or neck of the femur.

It is suggested that the use of a large sized reading glass will help materially in the interpretation of the roentgenograms presented.

COMMENTS

As a result of our experience it seems reasonable to conclude that the injection method is a practical way of studying the vascular pattern in the head and neck of the femur at different age levels. By this method we have been able to visualize the development of the blood supply which nourishes the ossifying center in the head of the femur during the entire growth period. It also has been possible by this method of study to become informed of the location of the course of the vessels within the femoral neck and head which nourish the growth area from the beginning through to its completion. Obviously such knowledge should prove to be both helpful and satisfying in any approach to a better understanding and treatment of certain hip conditions often met in children. We have in mind especially Legg-Perthes' disease and the so called slipped epiphysis.

CONCLUSIONS

1. The ossifying center in the developing head of the femur in infants and children receives its blood supply from the visceral capsule vessels which arise from the median circumflex artery.

2. The ligamentum teres vessels do not enter the head of the femur in children, nor do they contribute to the nourishment of the growing femoral head, except for very small vessels which accompany the fibrous tissue at the implantation of the ligamentum teres into the fovea area.

3. The anastomosis between the ligamentum teres vessels, the capsular arteries and the nutrient artery of the shaft does not take place until the ossification of the head of the femur is practically, if not entirely complete, at which time the vessels of the three systems unite by penetrating the thinned out cartilage area at the fovea, thus establishing the anastomosis.

4. The ligamentum teres circulation is a closed circulation in so far as the femoral head is concerned until such an anastomosis takes place.

REFERENCES

1. Anschuetz. Deut. med. Wschr., 1925, 51: 1473.
2. Bergmann. Deut. Zschr. Chir., 1927, 206: 12.
3. Bonnet. Tr. Acad. M. Ireland, 1885.
4. Cella. Chir. org. movim., 1934, 19: 207.
5. Chandler, A. Fremont. Wisconsin M. J., 1936, 35: 609.
6. Chandler, Simon B. West Virginia M. J., 1937, 33: 197.
7. Cooper. Citato da Hallermann.
8. Drevermann. Arch. klin. Chir., 1924, 129: 764.
9. Eggers. Citato da Logroscino.
10. Eliason, E. L., and Ferguson, L. K. Surg. Gyn. Obst., 1934, 58: 85.
11. Elgart. Acta chir. scand. 1927, 62: 454.
12. Harbin, M., and Zollinger, R. Surg. Gyn. Obst., 1930, 51: 145.
13. Hesse. Arch. klin. Chir., 1925, 34: 141.
14. Hildebrand. Zbl. Chir., 1924, 51: 119.
15. Hyrtle. Zschr. der K. K. Gesellschaft der Aerzte, Wien, 1846, 1: 58.
16. Iselin. Cor.-Bl. schweiz. Aerzte, 1918, 30.
17. Kolodny. J. Bone Surg., 1925, 7: 575.
18. Langer. Sitzher. Akad. Wiss. Mathnaturw. Cl., Wien, 1876, 36: 1.
19. Lexer. Patholosische Vorgange am Knochensysteme. Berlin: Hirsch Wald, 1904.
20. Logroscino. Chir. org. movim. 1934, 19: 295.
21. Luschka. Die Anatomie des Menschens. Vol. 2, sect. 1, 314. Tuebingen: H. Laupp, 1865.
22. Mazzarella, Oresta. Policlinico, 1937, 44: 101.
23. Moser. Schwalbe's Morphologische Arbeiten, 1893, 36.
24. Nussbaum. Beitr. klin. Chir., 1924, 130: 495.
25. Ibid., 1926, 137: 332.
26. Palletta. Merckel's Arch., 4.
27. Sappey. Tratato di Anatomia descrittiva, Napoli, 1878, vol. I, page 669.
28. Schmorl. Münch. med. Wschr., 1924, 71: 1381.
29. Stewart, W. J. J. Bone Surg., 1933, 31: 413.
30. Walmsley. J. Anat. Physiol., 1915, 49: 434.
31. Zemansky and Lippmann. Surg. Gyn. Obst., 1929 48: 461.

CHEMICAL CONSIDERATIONS GOVERNING THE LOCAL CHEMOTHERAPY OF WOUND INFECTIONS

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ALTHOUGH it is well recognized that the concentration of hydrogen ions fundamentally influences most physiological processes, its effect upon the healing of wounds and epithelization has not been investigated extensively. While the hydrogen-ion concentration (pH) of different tissues varies considerably, it deviates only in special instances from that of the circulating blood. The importance of maintaining hydrogen-ion concentration in tissue repair is suggested by the fact that tissue growth in culture media proceeds at an optimum rate at hydrogen-ion concentration 7.3.

Most pathogenic bacteria on the other hand produce acid from their metabolites, particularly from carbohydrates, although there are several exceptions especially among those with predominantly proteolytic activities. Although few data are in the literature on the hydrogen-ion concentration of infected wounds there is general agreement that infection produces acidity. In a recent study[1] the hydrogen-ion concentration of grossly infected wounds was found to be below pH 6 and in some instances approached pH 5. As the infection clears up the hydrogen-ion concentration of the wound secretions decreases, while in a clean healing wound it is usually about pH 7.3.

From Menkin's data, it appears that inhibition of wound repair in infected wounds may be due at least in part to the low hydrogen-ion concentration of pus. An interesting example of this effect occurs in the treatment of burns with tannic acid solution (pH of 3.5 to 4). The purpose of using tannic acid is to produce a clogging effect by precipitating protein on the burned surface, a process frequently considered similar to the tanning of hides although different in many respects. The precipitation of proteins by tannic acid is incomplete or even absent at neutral or slightly alkaline reaction and its optimum is at about pH 4. Eschar formation at alkaline reaction may therefore be delayed considerably. Moreover, the alkaline tannates are highly susceptible to oxidation, which is further favored by the fine state of subdivision brought about by spraying in air. The use of tannic acid at pH 7 is therefore impractical. It is now gradually becoming recognized that the treatment of burns with tannic acid solutions of low hydrogen-ion concentration is to some extent a compromise, and in borderline cases tissue destruction by tannic acid may convert a second degree burn into a third degree burn.

In this connection, it is of interest to note that some of the established agents used in wound and burn therapy are buffered to slightly above neutrality. This seems to be more than mere coincidence. The hydrogen-ion concentration of Dakin's solution is pH 8.5; of zinc peroxide suspension, pH 7.8; of azochloramid solution, pH 7.4; of Pickrell's solution, pH 9.0.

The influence of hydrogen-ion concentration on the effect of various antibacterial agents has been extensively investigated. It has been found that most agents possess a more or less wide hydrogen-ion concentration range of optimum activity and that the activity of antibacterial chemicals usually decreases at high acidity and alkalinity (4, 5). It is also known that the effectiveness of agents of a basic nature, such as quaternary ammonium derivatives, acridine dyes, and similar agents, increases with a rise of hydrogen-ion concentration, whereas that of acid agents, as the halogens, phenols, and the like, decreases with increasing hydrogen-ion concentration.

Effect of hydrogen-ion concentration on the action of sulfonamides. Recently our laboratory and others drew attention to the importance of the ampholytic character of the sulfonamides (3, 19). (Ampholytes are compounds which can act as acids or bases, depending on the hydrogen-ion concentration of the medium). The effect of hydrogen-ion concentration on sulfonamide ac-

Because of his outstanding contributions in the field of chemotherapy, the late Dr. Schmelkes was invited by the Regents of the American College of Surgeons to participate in the 1942 Clinical Congress of the College, which had to be cancelled because of the war emergency. It is fortunate for all of us that Dr. Schmelkes' paper was completed shortly before the untimely death of this brilliant scientist. The members of the Department of Surgery of the Johns Hopkins Medical School consider themselves fortunate in having been in close association with Dr. Schmelkes, and his co-operation and advice have been very helpful to all of us. I take personal pride in having requested the preparation of this, his last paper.—ALFRED BLALOCK

From the Research Department Wallace & Tiernan Products, Inc.

[1]Dr. James A. Dingwall, Department of Surgery, Cornell University Medical School, personal communication.

TABLE I.—EFFECTIVENESS OF VARIOUS SULFONAMIDES IN OVERCOMING THE ACTION OF *P*-AMINOBENZOIC ACID, AS MEASURED AGAINST ESCHERICHIA COLI IN A SYNTHETIC MEDIUM

Mol. of PAB per Mol. of Sulfonamide

pH	SA ($K=2.2\times10^{-11}$)	SP ($K=5.1\times10^{-9}$)	ST ($K=6.2\times10^{-8}$)
5	.000010	.00051	.004
5.5	.000030	.00080	.008
6.0	.000069	.0015	.012
6.5	.00023	.0040	.022
7.0	.0003	.0095	.049
7.5	.0012	.019	.045

SA=Sulfanilamide SP=Sulfapyridine ST=Sulfathiazole

tion *in vitro* was thoroughly investigated, and it was found that sulfonamides behave as though their effectiveness were proportional to their acid strength. Results of experiments given in Table I show that the antibacterial effectiveness of various sulfonamides increases with increasing hydrogen-ion concentration throughout a relatively wide hydrogen-ion concentration range.

These observations may have some bearing on the accepted theory which explains the action of sulfonamides on the basis of competition with *p*-aminobenzoic acid which is a stronger acid than any of the commonly used sulfonamides. The competitive antagonism between *p*-aminobenzoic acid and sulfonamides is usually explained on the basis of their close structural similarity which enables the sulfonamides to block that part of an essential enzyme that is usually occupied by *p*-aminobenzoic acid (21, 22). Since it has been found that the anionic form of the sulfonamides competes with *p*-aminobenzoic acid on much more favorable terms than the molecular form, at least at or below pH 7, a rise in the hydrogen-ion concentration of the surrounding medium causes increased dissociation of the sulfonamide molecules into anions and greatly increases their antibacterial effectiveness.

TABLE III.—EFFECT OF HYDROGEN-ION CONCENTRATION ON GROWTH INHIBITION OF STREPTOCOCCUS FECALIS* BY SULFONAMIDES

Compound	mgm. % required to reduce growth to ½ maximum rate at pH 7	pH 9
Sulfanilamide	1.00	0.010
Sulfapyridine	0.20	0.009
Sulfathiazole	0.04	0.008

*This organism grows readily in synthetic media at pH 9.

TABLE II.—ION ACTIVITY OF SULFONAMIDES*

pH	$(SA^-)/(PAB^-)$	$(ST^-)/(PAB^-)$	$(SP^-)/(PAB^-)$	$(SAC^-)/(PAB^-)$
5.5		3.24	3.10	200‡
6.0	.32	3.57	3.58	210‡
6.5	.58	4.04	3.42	230‡
7.0	.56	6.1		172‡
8.0	.64	6.6		

*The values given are arrived at by determining the concentrations of *p*-aminobenzoic acid and sulfonamide at which the growth rate of the test organisms is reduced to one-half maximum. The anion concentrations are then calculated from the dissociation constant and the hydrogen-ion concentration. The values of the fraction sulfonamide anion/*p*-aminobenzoic acid anion (expressed in mols.) are given in the table. SA=sulfanilamide, ST=sulfathiazole, SP=sulfapyridine, SAC=sulfacetimide.

‡Estimated from determinations carried out at slightly different hydrogen-ion concentration values.

A careful quantitative investigation has shown that regardless of the hydrogen-ion concentration, the competitive ratio of the anions of the sulfonamides to the *p*-aminobenzoate ion (SX^-/PAB^-) at equal growth inhibition is a characteristic of each compound.

A comparison of various sulfonamides showed that each of them possesses a specific anionic activity and that sulfanilamide leads the list. While each sulfanilamide anion can overcome from 1.5 to 3 *p*-aminobenzoate ions, 3 to 6 sulfathiazole ions and 200 sulfacetimide ions are required to suppress the action of one *p*-aminobenzoate ion. This high activity of the sulfanilamide anions should not be confused with the fact that sulfanilamide is the least effective of the commonly used sulfonamides when they are compared on a weight basis at pH 7. As the hydrogen-ion concentration is raised, increasingly larger fractions of the total sulfanilamide dissociate into the much more powerful anionic form with a simultaneous increase of the antibacterial effect. Table III shows that at pH 9 the activity of sulfanilamide about equals that of sulfathiazole and sulfapyridine. Since sulfanilamide is very much more soluble than sulfathiazole and sulfapyridine, a nearly saturated sulfanilamide solution at pH 9 should be more effective than that of any other sulfonamide.

Since the systemic hydrogen-ion concentration cannot be influenced by medication, these considerations are not applicable except in local chemotherapy where buffered materials can be used to maintain the hydrogen-ion concentration at a level favorable to sulfanilamide action.

These findings provide an explanation for many contradictions in the literature and point to the necessity of carrying out all comparative studies of sulfonamide action upon bacteria in heavily

buffered media in order to exclude variations in hydrogen-ion concentration level due to the metabolic activities of the bacteria under investigation. Furthermore, these observations suggest that in local sulfonamide therapy the hydrogen-ion concentration level be raised to a point as high as is compatible with physiological processes. Finally, it appears to be advisable to apply instead of the more complex relatively insoluble sulfonamides, the more freely soluble sulfanilamide, which is not only equally effective on a weight basis but in addition is present in a higher local concentration.

Recently Roblin and Bell presented an ingenious hypothesis correlating chemical structure with the activity of various sulfanilamide derivatives. They suggest that the acidic dissociation constant of the sulfonamides determines the state of polarization of the sulfone group which in turn is responsible for the sulfonamide activity. Some of our experimental findings quite agree with this hypothesis.

Effect of certain polar compounds upon sulfonamide action. In addition to the polar groups in the sulfonamide molecule which have been shown to be factors of paramount importance, it is not at all impossible that the hydroxyl ions of the surrounding medium which increase in concentration as the hydrogen-ion concentration level is raised may have an effect of their own upon sulfonamide action.[1] With other polar compounds such effects have been demonstrated. Urea (9, 15, 20) and asparagin[2] exert in some manner, so far not understood, a "medium effect" upon either the sulfonamides or the bacteria. Asparagin is actually a growth stimulant, in the presence of which bacteria proliferate more rapidly. To our knowledge it is the only compound known to stimulate bacterial growth and to enhance sulfonamide activity at the same time.

Inactivation of sulfonamide inhibitors. In addition to the enhancement of sulfonamide action by adjustment of the hydrogen-ion concentration to the optimum value compatible with physiological conditions by use of the "medium effect" of one or the other polar substance, sulfonamide action may also be greatly enhanced by direct inactivation of the specific sulfonamide inhibitors which are always present in pus, necrotic tissue, etc. Recent evidence points to the possibility that this may be effectively and almost selectively accomplished by the action of mild oxidizing agents, particularly by some of the chlorine compounds (6, 12, 13, 14, 20). As all organic matter including the sulfonamides reacts with oxidizing agents, the use of a highly selective chlorinating compound is indicated and has actually been found to give the best results. If the inhibitor in pus is identical with *p*-aminobenzoic acid it is noteworthy that a trace of azochloramid, less than the concentration required to show a material effect upon the bacteria present, is able to inactivate an amount of *p*-aminobenzoic acid present in the pus of infected wounds.

Another interesting phenomenon is the marked effect azochloramid has upon strains which have become resistant to the action of sulfonamides.

At the present time this effect has been demonstrated only with oxidizing agents such as azochloramid (Table VI).

TABLE IV.—EFFECT OF UREA AND ASPARAGIN UPON THE INHIBITION OF ESCHERICHIA COLI BY SULFANILAMIDE

mgm. % sulfanilamide	Turbidity after 21 hours		
	Sulfanilamide alone	Sulfanilamide +1% urea	Sulfanilamide + 2% asparagin
15	0	0	0
10	6	0	0
5	251	0	0
3	263	22	0
2	263	129	12
1	245	240	34
0.5	245	235	363
0.2	252	247	363
0	237	247	368

Inoculum 100,000 organisms per c.c. of McLeod's medium.

TABLE V.—EFFECT OF AZOCHLORAMID AND *P*-AMINOBENZOIC ACID ON THE INHIBITION OF ESCHERICHIA COLI BY SULFANILAMIDE

Sulfanilamide	Concentrations mgm. %		Turbidity (16 hrs.)
	p-Aminobenzoic acid	Azochloramid	
0	0	0	34.0
0	0	0.1	31.0
50	0	0	1.8
50	0.1	0	33.5
50	0.05	0	26.0
50	0.01	0	2.0
50	0.1	0.1	1.5

[1] Some of our unpublished data indicate that the hydrogen-ion concentration level also influences the effectiveness of the molecular form of the sulfonamides independently of their dissociation into anions. These new findings present new interesting theoretical problems.

[2] Unpublished data of Dr. Orville Wyss.

TABLE VI.—EFFECT OF AZOCHLORAMID AND SULFANILAMIDE UPON SULFANILAMIDE-FAST ESCHERICHIA COLI

Inoculum 2,000,000 Escherichia coli per milliliter

Sulfanilamide mgm. %	Azochloramid mgm. %	Turbidity 15 hrs.
0	0	49.0
100	0	45.0
25	0	47.5
0	0.04	44.0
5	0.04	0.5

Application of these findings in the local therapy of wounds and burns. As has been shown, infected wounds are acid. Sulfonamides in general are much less active under acidic conditions and between pH 5 and 6 even the more active compounds, sulfathiazole and sulfadiazine, exhibit only a fraction of their maximum activity. The activity of sulfonamides can be increased by raising the hydrogen-ion concentration, which increases their dissociation and apparently also increases the effectiveness of the molecular form. While the more active compounds, sulfathiazole and sulfadiazine, are largely dissociated at pH 7, the activity of sulfanilamide can be raised to that of sulfathiazole and sulfadiazine by raising the hydrogen-ion concentration from slightly above the neutral point up to pH 9. Due to the much greater solubility of sulfanilamide, a local chemotherapeutic effect might be had at pH 9 that would exceed that of sulfathiazole and sulfadiazine.

A dusting powder was therefore prepared which consisted of sulfanilamide buffered with calcium carbonate to approximately pH 8.8. Calcium carbonate was selected because it acts not only as a buffer but also as a reservoir of buffer. Calcium carbonate is insoluble and becomes soluble only to the extent that acid is produced in the wound and that its buffering ability is called into play. Thus it is possible to insure the presence of adequate amounts of buffer for about as long a period as sulfanilamide is present in the wound.

Recently the sodium salts of sulfonamides have been proposed for local chemotherapy (2). It should be borne in mind that some of the sodium salts of sulfonamides are too alkaline for use on tissues, while others which yield less alkaline sodium salt solutions, such as sulfathiazole and sulfadiazine, do not increase in activity when the hydrogen-ion concentration level is raised beyond that of the tissues. The use of sparingly soluble buffer is indicated because it maintains the alkaline reaction for a relatively long period of time.

TABLE VII.—THE VALUE OF BUFFERED SULFANILAMIDE IN PROPHYLAXIS

No. of cases	Drug employed 0.5–1.5 gm.	Primary healing Cases	%	Infected wounds Cases	%	Average no. of days in hospital after excision
32	Sulfanilamide	22	69	10	31	27.9
5	Sulfathiazole	5	100	None		22.0
29	None	21	72	8	27	24.8
28	Buffered sulfanilamide	27	96.4	1	3.6	18.8

The buffering action of highly soluble sodium sulfonamides is fleeting.

Preliminary clinical investigations with buffered sulfanilamide powder have borne out these theoretical considerations. Captain J. V. Scott at the Station Hospital at Fort Belvoir, Virginia,[1] has treated a series of contaminated wounds resulting from the excision of pilonidal cysts with the results shown in Table VII. These wounds were primarily closed after the chemotherapeutic agents were implanted. Calcium carbonate has additional theoretical advantages inasmuch as it has been shown by Hamburger that calcium ions stimulate phagocytic activity.

Another application of the buffering principle refers to the treatment of burns. It has been pointed out here that the acidity of tannic acid interferes with full utilization of the antibacterial effects of the sulfonamides. Moreover, the acidity of the solution itself may impair the rate of tissue repair. This was kept in mind in preparing the preformed therapeutic membranes which have recently been discussed by Andrus, Nickel and the writer in a preliminary communication. These membranes consist of a transparent hydrophilic plastic, contain 10 to 30 per cent sulfonamide and are buffered with calcium carbonate. They also contain urea which, as here mentioned, was found to enhance sulfanilamide action and a small quantity of sodium tetradecyl sulfate which reduces surface tension and provides adherence to the burns. The sterile film is moistened with azochloramid solution and then placed over the cleansed and débrided burned area, covered with a pressure dressing, and the lesion immobilized. In the treatment of second degree burns, for which this film has been largely utilized, rapid epithelization and freedom from infection has been reported. Quite recently Pickrell reported excellent results with a film of somewhat similar composition. The rapidity and simplicity of application does away with time-consuming spraying. During the first

[1] Improvement in immediate results of radical excision of pilonidal cysts with primary wound closure by the use of buffered sulfanilamide powder.—(in press).

TABLE VIII.—STREPTOCOCCAL EMPYEMA

Date	Treatment	Concentrations of sulfanilamide (mgm. %) in empyema fluid	Approximate number of streptococci per c.c. of empyema fluid
2- 4-42	S	12.65	>1,000,000
2- 5-42	S	9.38	5,000,000
2- 6-42	S	9.2	5,000,000
2- 7-42	S, AS	.....	.....
2- 8-42	S	.....	2,400
2-10-42	S	13.2	400
2-11-42	S	12.9	.....
2-12-42	S	8.52	8
2-14-42	S, AS	3.6	1
2-16-42	S	6.0	0

S=Sulfanilamide (per os).
AS=Azochloramid-sulfanilamide solution (intrapleurally).
.....=No determinations carried out.

48 hours the films are easily removable by simple sponging with a sterile aqueous solution. After the burn is healed the film flakes off spontaneously. From the military viewpoint it is of great importance that this film might be used successfully as an emergency dressing preceded by superficial cleansing only. After an interval of not more than 48 hours, definitive treatment can be instituted if it seems desirable to carry out thorough débridement. The emergency application prevents further damage to the patient at a time when the number of casualties overtaxes the available personnel and facilities. Finally, the compactness of this material makes it easy to ship which, under present conditions, is a desirable feature.

The clinical effect of oxidizing agents when used with sulfonamides has been discussed by Goldberger and by Neter, who have commented upon the rapid cleanup of local infections which were treated with mixtures of sulfonamides and azochloramid. A table taken from Neter's recent paper shows the effect of a few milligrams of azochloramid upon the bacterial count in an empyema fluid which was refractory to sulfonamide therapy alone. Neter has used freshly prepared mixtures of sulfanilamide and azochloramid. This is important because azochloramid slowly reacts with sulfanilamide and thereby loses its effectiveness (Table VIII).[1]

Methods of simultaneous application of azochloramid and sulfonamides were recently described by Hanrahan and by Long. They have also discussed indications for using this combination (8, 10).

[1] After extensive research it has been possible to produce a stable mixture of azochloramid and buffered sulfanilamide which, in the form of a sterile surgical dusting powder, has been used successfully in the treatment of wound infections.

SUMMARY

Recent studies of their mode of action have shown that the effectiveness of sulfonamides is greatly influenced by the hydrogen-ion concentration of their environment. This is due to the fact that the sulfonamide anions are much more active than the undissociated molecules. Among the sulfonamide anions, the sulfanilamide anions possess the greatest specific activity. At pH 8.5 to 9 sulfanilamide is not completely dissociated, yet it is as active as sulfathiazole or sulfadiazine. Some polar compounds, such as urea and asparagin, increase sulfonamide activity. Oxidizing agents, particularly azochloramid, also have an enhancing effect on sulfonamide action. This can be attributed to the destruction of sulfonamide inhibitors. The therapeutic applications of these findings is discussed.

REFERENCES

1. Andrus, W. De W., Nickel, W. F., and Schmelkes, F. C. Arch. Surg. In press.
2. Fox, C. L., Jr. Arch. Surg., 1942, 45: 754.
3. Fox, C. L., Jr., and Rose, H. M. Proc. Soc. Exp. Biol., N. Y., 1942, 50: 142.
4. Gershenfeld, L., and Perlstein, D. Am. J. Pharmacy, 1941, 113: 89.
5. Ibid., 1941, 113: 237.
6. Goldberger, H. A. Am. J. Surg., 1942, 56: 353.
7. Hamburger, H. J. Proc. Konink Akad. Amsterdam, 1910, page 66.
8. Hanrahan, E. M. Surg. Clin. N. America, 1942, 22: 1275.
9. Holder, H. G., and MacKay, E. M. Mil. Surgeon, 1942, 90: 509.
10. Long, P. E. Surg. Clin. N. America, 1942, 22: 1329.
11. Menkin, V. The Dynamics of Inflammation. New York: The Macmillan Co., 1940.
12. Neter, E. Proc. Soc. Exp. Biol., N. Y., 1941, 47: 303.
13. Idem. J. Pharm. Exp. Ther., 1942, 74: 52.
14. Idem. Am. J. Surg., 1942, 58: 69.
15. Olson, M., Slider, E., Clark, W. G., and MacDonald, R. Proc. Soc. Exp. Biol., N. Y., 1942, 49: 396.
16. Pickrell, K. L. Bull. Johns Hopkins Hosp., 1942, page 304.
17. Roblin, R. O., Jr., and Bell, P. H. Presented before the Division of Medicinal Chemistry of the American Chemical Society, Buffalo, New York, September 1942.
18. Schmelkes, F. C., and Wyss, O. Proc. Soc. Exp. Biol., N. Y., 1942, 49: 263.
19. Schmelkes, F. C., Wyss, O., Marks, H. C., Ludwig, B. J., and Strandskov, F. B. Proc. Soc. Exp. Biol., N. Y., 1942, 50: 145.
20. Tsuchiya, H. M., Tenenberg, D. J., Clark, W. G., and Strakosch, E. A. Proc. Soc. Exp. Biol., N. Y., 1942, 50: 262.
21. Woods, D. D. Brit. J. Exp. Path., 1940, 21: 74.
22. Wyss, O. Proc. Soc. Exp. Biol., N. Y., 1941, 48: 122.

THE MAXIMAL VOLUME OF THE HUMAN SPLEEN

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ONE of the romantic episodes in medicine is the accidental way in which the function of the spleen as a blood reservoir was discovered. In 1921 Barcroft and his party were on a voyage to the Peruvian Andes to study mountain sickness. On reaching tropical waters, members of the party discovered that the blood volume and the concentration of hemoglobin had increased, whereas, after they crossed the equator and reached colder regions, these values declined again. It appeared that the extra amount of blood had been first released from and subsequently returned to a considerable but then hidden storehouse. The spleen was suspected of being such a reservoir. Experiments on animals in the laboratories in the course of time proved this to be true.

The weight of a normal spleen from an adult man is notoriously susceptible to great variations. In one standard textbook of human anatomy the range was set between 100 and 250 grams, whereas in another it was put at 80 to 300 grams. In a statistical study of the weights of 4,000 normal spleens, Krumbhaar and Lippincott found the average weight of the spleen to be 170 grams when a person is from 16 to 20 years of age, 155 to 160 grams when the person is between 26 and 65 years old and progressively less after the age of 65 years has been attained. Kaufmann believed that spleens weighing more than 120 grams probably are not normal, whereas Bell considered any spleen weighing more than 300 grams as nearly always abnormal in some respect.

Ahronheim has demonstrated by experiments with modeling clay that one cannot compute without gross error the volume of the spleen on the basis of measurements of the length, width, and thickness of the organ. The author cannot agree with him, however, that weight appears to be the most nearly accurate way of expressing the size of an organ.

The efficiency of the spleen as a blood reservoir would be limited, indeed, if its capacity were adjudged on the basis of weight as determined at postmortem examination. Bunting has pointed out that the difference between the weight of a normal human spleen and that of another washed free of blood is only 40 to 50 grams. It would seem, however, that the crux of the matter lies rather in the magnitude of the difference between the volume of the spleen during life and the volume of the same spleen after death. Barcroft and his colleagues demonstrated in the cat the striking phenomenon that the spleen during life might be two to four times greater than it is after death from hemorrhage or drowning has occurred. Does this apply to the spleen in man? The answer is hard to obtain, because in the medical literature there is a dearth of information on the maximal volume of the human spleen.

The work was done under the direction of Dr. H. E. Robertson, Section on Pathologic Anatomy, Mayo Clinic. Dr. Wu, fellow, Mayo Foundation.

NATURE OF THE STUDY

The purpose of this study was to inquire into the maximal volume of the normal spleen in man with particular reference to its provision of a potential space for the storage of blood. Since the medical profession is now keenly interested in the question of blood banks, this seems to be an opportune time at which to assay the capital that may exist in reserve in this autonomous bank in the human body.

MATERIAL AND METHOD

The material used in this study consisted of spleens which were obtained from a series of 20 unembalmed bodies at postmortem examination at the Mayo Clinic. Fourteen spleens were obtained within 4 hours after death of the patients and 5 others in less than 9 hours after death of the patients. One spleen was taken from a patient who had died 3 days previously at another hospital.

Spleens were secured from 15 males and 5 females, whose ages had ranged from 16 to 89 years. There was 1 patient each in the second and fourth decades; 2 patients each in the third and fifth decades, 4 each in the sixth and seventh decades, and 3 each in the eighth and ninth decades. The height of the males varied from 158 to 187 centimeters, and that of the females varied from 155 to 172 centimeters. The weight of the males ranged from 90 to 201 pounds (41 to 91 kgm.), and that of the females from 100 to 150 pounds (45 to 68 kgm.). The surface area was computed according to the formula of Dubois, with the aid of the nomogram devised by Boothby and Sandiford.

TABLE I.—MEASUREMENTS OF TWENTY SPLEENS OBTAINED AT NECROPSY AND CERTAIN DATA CONCERNING PATIENTS FROM WHOM SPLEENS WERE OBTAINED

Case No.	Patient					Spleen				Body	
	Sex	Age	Height, cm.	Weight, lb.	Surface area sq. meter	Weight, gm.	Initial volume, c.c.	Maximal volume, c.c.	Difference in volume, c.c.	Computed blood volume, c.c.	Spleen-body blood volume ratio, per cent*
507	M	16	184	125	1.75	145	140	225	85	5775	1.5
561	M	24	178	126	1.72	255	235	440	205	5676	3.6
547	M	25	187	140	1.86	355	320	650	330	6138	5.4
582	F	38	161	100	1.44	105	105	310	205	4752	4.3
118A	M	46	186	145	1.88	265	230	365	135	6204	2.2
526	M	48	183	170	1.99	270	250	650	400	6567	6.1
132A	M	51	177	165	1.92	200	200	480	280	6336	4.4
142A	M	55	172	125	1.67	200	180	375	195	5511	3.5
589	M	55	176	200	2.08	300	300	450	150	6864	2.2
600	M	57	177	135	1.76	140	150	425	275	5808	4.7
515	F	64	156	145	1.66	110	100	200	100	5478	1.8
539	M	65	168	127	1.65	150	140	250	110	5445	2.0
559	M	66	180	201	2.12	360	350	500	150	6996	2.1
120A	F	67	155	102	1.42	135	125	285	160	4686	3.4
522	F	70	172	150	1.80	185	175	315	140	5940	2.4
131A	M	72	171	140	1.74	235	225	500	275	5742	4.8
628	F	76	162	110	1.52	130	137	300	163	5016	3.2
122A	M	80	160	115	1.53	115	125	200	75	5049	1.4
126A	M	82	165	90	1.41	60	60	120	60	4653	1.3
585	M	89	164	115	1.56	105	140	355	215	5148	4.2

*Computed thus: in case 526 the computed blood volume of the body was 6,567 c.c. The spleen in the same case had a potential capacity to store 400 c.c. of blood, which is 6.1 per cent of the total blood volume of the body (6,567 c.c.).

Only those spleens which were normal on inspection and palpation were used in this study. Twenty such spleens were secured. First, they were weighed. The volume of the spleen was determined by noting the amount of water displaced when the spleen was submerged in that medium. Henceforth in this study this particular volume will be called the "initial volume" of the spleen.

Next, a glass cannula was inserted into the splenic artery and tied in place. A piece of rubber tubing was used to connect the cannula with a water faucet. The spleen was immersed in water, and air was removed from the perfusion system. The tap water was turned on gradually, until the spleen became distended and blood began to issue freely from the splenic vein. Perfusion was continued for from 15 minutes to half an hour, until the maximal amount of distention, short of that which would produce rupture of the splenic capsule, was obtained. Then the volume of the spleen was determined again by the method of displacement of water. The volume thus obtained will be called the "maximal volume" of the spleen. The difference between the maximal and the initial volumes of the spleen is taken as the potential capacity of the organ as a blood reservoir (tenth column in Table I).

RESULTS

Pertinent data and results of this study are given in Table I. The volumetric determinations are graphically represented in Figure 1. A number of points seem to be interesting enough to need elaboration.

The weights of the spleens in this series varied from 60 to 360 grams. Sixteen of the 20 spleens weighed between 105 and 270 grams.

The initial volumes of the spleens varied from 60 to 350 cubic centimeters. Both of the patients concerned were males, 82 and 66 years old, respectively. The range of variation in initial volume among the females was between 100 and 175 cubic centimeters. Twelve of the 20 spleens had initial volume between 100 and 200 cubic centimeters, inclusive.

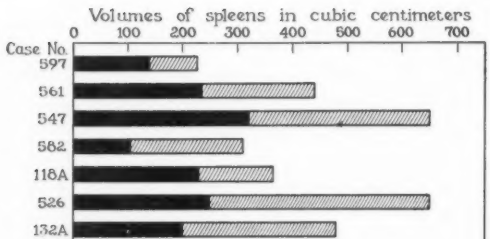

Fig. 1. The initial volume of the spleen is represented by the solid black area. The difference between the maximal and the initial volumes of the spleen is represented by the hatched area. The solid black and the hatched areas together represent the maximal volume of the spleen. Note particularly cases numbered 526, 547, 132a, 600 and 131a.

The maximal volumes of the spleens varied from 120 to 650 cubic centimeters; these values apply to the 15 males as well as to the whole series (Table I). The spleens from the 5 females had maximal volumes of 200, 285, 300, 310 and 315 cubic centimeters. It is noteworthy that only 4 spleens in the series of males had volumes less than 350 cubic centimeters (120, 200, 225 and 250 c.c., respectively) and that the remaining 11 spleens had volumes in excess of that figure.

The ratios between the maximal and the initial volumes of the spleens are summarized in Table II. The maximal volumes of 8 spleens were one and a half times to twice the corresponding initial volumes. In the case of 8 other spleens, the maximal volumes were two, to two and a half, times the initial volumes. It is particularly noteworthy that the remaining 4 spleens possessed maximal volumes which were two and a half to three times the initial volumes. In other words, the volume of the spleen during the life of the patient could be two to three times that after death in 3 out of every 5 cases in this study (Table II).

TABLE II.—MAXIMAL VOLUMES OF SPLEENS

Ratio to initial volume*	Spleens, no.
1.5 to 2.0 times	8
2.0 to 2.5 times	8
2.5 to 3.0 times	4

*"Initial volume" taken as 1 in this table.

The difference between the maximal volume and the initial volume of the spleen gives the most instructive figure in this study (Table I). As pointed out previously herein, it represents the potential capacity of the spleen as a blood reservoir. It should be said at this time that much blood was washed out during perfusion in all the specimens, without exception. The actual potential space in the spleens must therefore be appreciably greater than the figures here given would indicate.

The potential capacities of the spleens which were measured in this study varied from 60 to 400 cubic centimeters. This range applied to the spleens from the males as well as to those in the whole series. In the case of the females, the range of variation was between 100 and 205 cubic centimeters (Table I). Measurement of 5 spleens in respect to potential capacity, produced these significant figures: 275, 275, 280, 330 and 400 cubic centimeters.

OBSERVATIONS

Most of the material used in this study was obtained from elderly persons, as is apparent in Table I. Only 4 patients had been younger than 45 years of age, whereas exactly half of the total number were more than 60 years old. Because the spleen serves much like a mechanical, chemical, and biological filter in the economy of the body, it is difficult to conceive of any systemic disease which would not leave, in its wake, certain alterations in the capsule and the connective tissue framework of the spleen. To this may be added the as yet ill-understood structural expression of senescence itself. The consequence is that the expansibility and contractibility of the organ must necessarily, albeit varying in degree, diminish during the span of life of any person. In other words, the capacity of a perfectly "normal" spleen to serve as a blood reservoir should be even greater than the results of this investigation would indicate, since most of the spleens in this study were obtained from persons already "senescent" at the time of death. In fact, the situation of the spleen in the portal circulatory system would lead one to suspect that the peak of its efficiency in this important rôle might be reached during the fetal life of the person.

The initial volume of the spleen as measured in this study merely provides a sort of base-line for each individual case. It possesses no value whatsoever for comparison among cases. The reason is that the initial volume is dependent on the degree of distention or collapse of the organ. A multitude and diversity of factors may play varying rôles during the terminal period of life. As examples may be mentioned hemorrhage, shock, collapse, asphyxia, and physical exertion, all of which cause contraction of the spleen. The administration of epinephrine, pituitrin, and other sympatheticomimetic drugs is known to exert the same effect. The effects of the transfusion of blood and of venoclysis of various solutions may be reflected in an opposite direction. Finally, such conditions as congestive heart failure, cirrhosis of the liver with portal hypertension, and mechanical obstruction in the portal venous system tend to impede the emptying of the spleen. It is thus easy to comprehend why the initial volumes varied so much as from 60 to 350 cubic centimeters. The wonder is that the discrepancy was not greater.

On the other hand, the maximal volume of the spleen is free from the influence of such variable factors. It is obtained under a constant set of experimental conditions. Theoretically, the capacity of the spleen for the storage of blood should vary directly in proportion to its maximal volume. But this relationship is nullified by the great variation in the initial volume of the spleen, as noted previously herein. Take, for example, the two spleens which had a maximal capacity of 500 cubic centimeters each (Table I). The capacity for blood storage as estimated by the method of measurement employed in this study would be 275 cubic centimeters for one as against 150 cubic centimeters for the other. The difference between them is the difference between the initial volumes of 225 and 350 cubic centimeters, respectively.

When the maximal volume of the spleen is plotted against the surface area of the person from whom the spleen was taken, a positive linear relationship between the variables is seen (Fig. 2). The line in the figure was calculated according to the method of least squares. Four of the five females had surface areas of less than 1.70 square meters, whereas 10 of the 15 males had surface areas greater than that figure. Interestingly enough, the maximal volumes of the spleens in the males and the females tended to group themselves above and below 325 cubic centimeters, respectively. It may be stated that the maximal volume of the spleen seems to vary directly in proportion to the surface area.

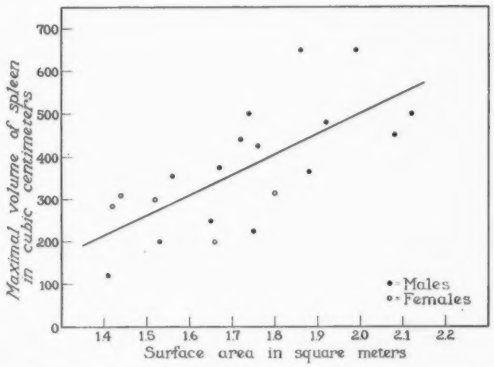

Fig. 2. The maximal volume of the spleen is plotted against the surface area of the person concerned. The line is calculated according to the method of least squares. Note the positive linear relationship between the variables.*

The difference between the maximal and the initial volumes of the spleen as reported in this study represents only the lower limit of the potential capacity of the organ as a blood reservoir. The evidence thereof lies in the fact that it required from 30 minutes to 2 hours of continuous perfusion to rid the spleen of its residual content of blood. In other words, the actual storage space available in the spleen must be appreciably greater than the figures obtained in this study would indicate. In view of this fact, particularly significant are these figures: 400, 330, 280, 275 and 275 cubic centimeters, seen in the tenth column of Table I. In terms of percentage of the total blood volume calculated on the basis of 3.3 liters per square meter of surface area (Rowntree and Brown), these amounts are equivalent to 6.1, 5.4, 4.4, 4.7 and 4.8 per cent, respectively as seen in the last column of Table I. These spleens should be able to carry out autotransfusion of a considerable amount of blood when the demand for it arises. Provisions such as this testify to what Cannon called "the wisdom of the body."

The weights of the spleens in this series varied from 60 grams in 1 case to 366 grams in another. If the specific gravity of the blood is taken to be 1.055, the 60 gram spleen when distended with blood would weigh 123 grams and the 366 gram spleen when distended with blood would weigh 518 grams. An extreme instance was found in the case of the spleen which weighed 270 grams. When it was distended with blood, that spleen would weigh 692 grams, which is two and a half times the actual weight. The anatomists and the

*The author is indebted to Mr. Robert P. Gage, of the Division of Biometry and Medical Statistics of the Mayo Clinic, for his assistance in the statistical analysis.

pathologists therefore should correlate the weight of the spleen with its degree of distention or collapse. One begins to wonder when one should use the erudite polysyllabic term "splenomegaly," which, to begin with, has no more meaning than that expressed by "an increase in size and weight of the spleen." Certainly, the clinician who has been able to palpate a spleen during the life of a patient would have to subdue his feeling of pride in the feat when he sees the same, but more or less contracted spleen at postmortem examination.

SUMMARY AND CONCLUSIONS

The volumes of 20 spleens obtained from unembalmed bodies at postmortem examination were measured by means of the amount of water they displaced. Then the spleens were distended by perfusion with water to produce maximal volumes.

The initial volumes of the spleens varied from 60 to 350 cubic centimeters. The factors which could be responsible for such variation have been pointed out. It is suggested that the weight of the spleen should be correlated with its degree of collapse or distention with blood.

The maximal volumes of the spleens seemed to vary in direct proportion to the surface areas of the patients. The values for maximal volume ranged between 120 and 650 cubic centimeters. They represented one and a half to two times the initial volumes in the case of 8 spleens, two to two and a half times in 8 other spleens, and two and a half to three times in the remaining 4 spleens.

The difference between the maximal and the initial volumes of each spleen represented in large measure the potential space available for storage of blood. This varied from 60 to 400 cubic centimeters. Great significance was attached to 5 spleens which possessed the capacity to accommodate 275, 275, 280, 330 and 400 cubic centimeters of blood, representing 4.8, 4.7, 4.4, 5.4, and 6.1 per cent, respectively, of the total blood volumes of the patients concerned.

REFERENCES

1. Ahronheim, J. H. Arch. Path., Chic., 1937, 23: 33–52.
2. Barcroft, Joseph. Lancet, Lond., 1925, 1: 319–322.
3. Bell, E. T. A Text-book of Pathology. 4th ed. Philadelphia: Lea & Febiger, 1941.
4. Bunting, C. H. Diseases of the spleen. In Tice, Frederick: Practice of Medicine. Vol. 8, pp. 585–615. Hagerstown, Maryland: W. F. Prior Company, Inc., 1923.
5. Cannon, W. B. The Wisdom of the Body. New York: W. W. Norton & Co., Inc., 1932.
6. Gray, Henry. Anatomy of the Human Body. Philadelphia: Lea & Febiger, 1942.
7. Kaufmann, E. Pathology for Students and Practitioners. (Translated by Reimann, S. P.) Vol. 1, p. 816. Philadelphia: P. Blakiston's Son & Co., 1929.
8. Krumbhaar, E. B., and Lippincott, S. W. Am. J. M. Sc., 1930, 197: 344–358.
9. Morris, Henry. Morris' Human Anatomy. 10th ed., Philadelphia: The Blakiston Co., 1942.
10. Rowntree, L. G., and Brown, G. E. The Volume of the Blood and Plasma in Health and Disease. Philadelphia: W. B. Saunders Co., 1929.

HERNIATION OF THE NUCLEUS PULPOSUS

As a Complication of Pre-existing Low Back Instability

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THE object of this preliminary report is to urge the more general recognition of a group of patients in whom herniation of the nucleus pulposus is a complication of a preceding low back instability.

The relatively new entity of herniation of the nucleus pulposus has received increasing study and clarification throughout the past decade. An excellent summary of the work is given by Bradford and Spurling. The literature since that publication continues to give many further reports. While the condition is now a well established entity, it is apparent that it still presents certain unsolved aspects. With increasing recognition there are increasing numbers of patients being operated upon by the neurological surgeon. Many other patients, however, are actually being seen first by the orthopedic surgeon, because of the two complaints of low back and sciatic pain. Each specialist has in the past brought but one point of view to the problem. The viewpoints have necessarily been different. Controversial issues have not been simplified by some of the perhaps too positive statements made in each specialty.

The neurological surgeon is routinely diagnosing these conditions and operating upon such patients, and in the past at least he has been inclined to work without any routine collaboration with the orthopedic surgeon. In the uncomplicated case of herniated nucleus, the results have for the most part been very satisfactory. The patient nowadays receives a routine operation and is out of the hospital in about 3 weeks time. The good results in the majority of such cases have probably made the problem seem fairly simple. Most neurological surgeons are, however, becoming increasingly aware of the need of orthopedic help in solving some of their cases.

The orthopedic surgeon has been treating low back and sciatic pain for a much longer time. The orthopedic literature contains numerous reports of groups of patients cured of low back pain with "sciatica" by fusion. The orthopedic surgeon is rightly troubled to see certain patients who need a fusion, treated by laminectomy only. It is apparent from my own glances into the orthopedic literature that there are also several other orthopedic measures that are being used to relieve low back pain with "sciatica."

From The New York Orthopaedic Hospital & Dispensary.

It is likely, as with so many other conditions in the past, that clearer definitions and possibly the recognition of subgroups will actually simplify rather than complicate the issues. In the routine practice of neurological surgery, my own experiences with herniation of the nucleus pulposus (which form no part of the present report), have been similar to those of others. For purposes of description in this paper such uncomplicated cases of herniated nucleus will be referred to as group I. These patients give a fairly routine history. Most of their pain is sciatic pain with a minimum of low back pain. There is no outstanding preceding history of "back trouble." Orthopedic opinion in such cases is that of a stable low back and such patients require only removal of the herniated nucleus.

In my capacity as neurological surgeon to The New York Orthopaedic Hospital, however, I have had a quite different set of experiences. It leads me to urge the more general recognition of group II cases, i.e., herniated nucleus pulposus as a complication of a low back instability. I believe this condition should be looked upon as a distinct entity from the uncomplicated herniated nucleus. If this be done, many of the questions as to the need of fusion that we hear being discussed in the individual case will solve themselves. How common group II cases are, as compared with group I cases, cannot be told until many years of reports from clinics are available in such a new subject. Group II cases are not rare, however. The first series of 100 cases of patients operated upon in this hospital have now had a sufficiently long follow-up to make them a subject for a report which will follow soon, presenting both neurological and orthopedic aspects.

DESCRIPTION OF THE GROUP SEEN AT THIS HOSPITAL

The combination of low back and sciatic pains brings increasing numbers of these patients to orthopedic hospitals. It is important to describe clearly the group of patients seen here who have proved to have the combination of both orthopedic and neurosurgical lesions, i.e., an unstable

low back requiring fusion and herniation of the nucleus pulposus as well.

These patients were primarily orthopedic cases. They had been treated conservatively in the clinic or hospital for their low back instability, often for a long time. Because they proved refractive to conservative treatment, they constituted the 4 per cent of the clinic cases of this condition in which surgical fusion was advised. In this group of cases, all those complaining of sciatic pain routinely received a thorough neurological study before operation was planned. A considerable number of these patients proved to show neurological signs of a herniated nucleus. The neurological study and diagnosis, however, were secondary to the decision of the orthopedic staff for the need of fusion. Both operations were carried out together with satisfactory results.

Here then is a group of patients in whom both an orthopedic and a neurosurgical condition were responsible for their complaints. To me it convincingly establishes this combination as a quite separate group from uncomplicated herniation of the nucleus pulposus. These patients required the services of both the orthopedic and the neurological surgeons. The overlooking of either condition, numerous examples of which we have seen, almost surely means further trouble for the patient later. The recognition of combined orthopedic and neurosurgical cases is not new. Among those urging that such cases exist have been, Goldthwaite, Smith, Spurling and Bradford, Mixter (18) and Mixter and Barr (19).

Many men in both specialties have for long recognized the need in certain cases of close cooperation between the orthopedic and neurological specialists. Still lacking, however, is any general acceptance of this viewpoint. The general recognition of such combined cases should do much in clearing up many of the contested points on the subject of "low back and sciatic pain." This combined group has in the past several years become increasingly convincing to me. From my viewpoint even the patient's history differs from the uncomplicated herniated nucleus seen in routine neurosurgical practice. Besides the relatively recent and predominant complaint of sciatic pain, there is a long preceding history of low back pain and discomfort. In this special group it is my belief that herniation of the nucleus pulposus is secondary to and develops after the joint instability. Failure to recognize such cases almost certainly explains some of the failures of cure that both orthopedic and neurological surgeons have experienced. The relation between a preceding joint instability and subsequent herniation of the nucleus pulposus seems quite clear in this group. No such problem appears to exist in group I, the uncomplicated herniated nucleus.

THE DIAGNOSIS OF HERNIATED NUCLEUS

The diagnosis of herniation of the nucleus pulposus has been greatly clarified in the past few years. How simple or difficult its recognition still remains a question, as may be judged by even the most recent literature. The orthopedic surgeon, who sees many of these patients, is necessarily interested in the diagnosis of this condition.

The majority of clinicians even up to very recently have considered the neurological signs so vague that lipiodol has been generally used. From this has come many excellent special reports of the use of lipiodol in the diagnosis.

A few, but very few, have taken an extremely opposite viewpoint as to the difficulty of diagnosis. These would have us believe that the history alone in such cases is so typical that, with or without neurological signs, the diagnosis is simple.

My experience does not agree with either viewpoint. The diagnosis of herniated nucleus pulposus is neither particularly difficult nor simple. The lesion produces characteristic neurological signs. A careful neurological examination will accurately diagnose the presence of a herniated nucleus as well as its level, without recourse to lipiodol, in almost all cases. Lipiodol is not used in this hospital for the diagnosis.

"Neuralgia" and "neuritis." Before a description of the neurological signs produced by a herniated nucleus, it seems essential to urge a more exact use of the terms "neuralgia" and "neuritis." These terms are still used interchangeably in the literature. Adding to the confusion is the term "sciatica." "Sciatica" should either be discarded altogether or modified to "sciatic pain," its commonest present usage.

"Neuralgia" should be used as meaning pain and pain only. Sciatic neuralgia, i.e., sciatic pain, is a complaint, not an objective neurological sign. Sciatic neuralgia cannot be recognized. It is the patient's complaint and when caused by a herniated nucleus it disappears as soon as the nucleus is removed.

"Neuritis" as correctly used, implies abnormal or retrograde changes within a nerve. It is recognized clinically by functional losses in the end organs supplied by that nerve. In the case of the sciatic neuritis produced by the pressure of a herniated nucleus on a nerve, functional losses both sensory and motor are to be found in the end organs innervated by the afflicted nerve. The

motor and sensory losses due to the neuritis, constitute the neurological signs that make a reliable diagnosis. Thus while the patient with a herniated nucleus complains of sciatic neuralgia, the neurosurgical diagnosis is made on the signs of sciatic neuritis. Again, with removal of a herniated nucleus the pain (neuralgia) promptly ceases to exist, whereas the motor and sensory losses caused by the retrograde changes in the nerve (neuritis), persist for many months after operation as the nerve recovers (6). For example, an absent ankle jerk may not reappear for many months after operation. If neuralgia and neuritis were used consistently and correctly in the literature it would greatly simplify interpretations of reported results.

HISTORY

The history of herniated nucleus is that of sciatic neuralgia; that is, pain along the course of the sciatic nerve. While the history is very characteristic, it is of course not diagnostic, as some would claim. We all know that there are other causes of sciatic neuralgia besides a herniated nucleus. The complaint then is that of severe unilateral pain in the leg, experienced along the known course of the sciatic nerve. Pain along the front or lateral aspect of the leg is not sciatic pain. Generally speaking, but not invariably, the following facts hold true. The sciatic pain is increased by all back movements and by coughing or sneezing. It may or may not be improved by bed rest. It is generally unrelieved or made worse by physiotherapy. It is considerably increased when the patient bends toward the side of the pain. In the combined group seen at the Orthopaedic Hospital there is a good deal of low back pain. Moreover the story of low back pain and discomfort in this group is generally a long one, antedating the onset of sciatic neuralgia by months or years. The majority of the patients date the onset of the sciatic pain to a fall or a lifting strain.

General features. The patient may appear to be fairly comfortable or may be first seen in a severe attack of pain. In the latter event there is generally a protective limp and the back is bent forward. There is a flat low back from loss of the normal lumbar lordosis and the lumbar spine tends to curve away from the side of the pain. This feature as well as the increase of pain experienced with bending toward the side of the lesion are probably related to changes in the size of the intervertebral foramen, Danforth and Wilson. The postural deformities of the lower spine due purely to pain and spasm are sometime marked in such cases.

Neurological signs. The specific signs of herniated nucleus in the lower lumbar spinal canal are mild but definite. A careful neurological examination will reveal them. They are unilateral signs of mild losses in motor and sensory functions. They are caused by the retrograde neuritic changes in the nerve that is being compressed by the herniated nucleus. Either motor or sensory signs may predominate. Either, but not both, may be missing. When a number of these patients have been seen, the composite picture however is remarkably characteristic and uniform.

Motor signs. Muscle strength. The majority of these patients will show a little weakness in dorsiflexion of the foot on the affected side.

Muscle atrophy. This is commonly found. In general the longer the history, the more the measurable atrophy. Careful measurements are made at 15 centimeters above and below the patellas and the affected leg will usually show a little atrophy. Atrophy of the gluteal muscle on the painful side is very often found. The mild flattening of the normal contour is very definite. Few examiners look for it.

Reflex changes. Practically speaking; a reduced or absent ankle jerk will be found. It will generally prove true, however, that the sensory changes to be described, are a more reliable guide to the level of the herniated nucleus than are motor signs. Almost all patients have a reduced to absent ankle jerk, for example, yet the location of the herniated nucleus is not always at the fourth-fifth lumbar interspace.

Sensory changes. Most of the patients will show characteristic sensory changes along the outer side of the lower leg and on the foot. Indeed, many patients are aware of some numbness and mention it as part of the history. Sensation should be tested first for light touch, comparing the two legs. The patient's eyes should be closed. If patients can see light touch being tested for, they will generally give less correct answers. A light rubber band or cotton should be used. Diminution of pin prick will be found in the same area where light touch is diminished or lost.

Much has been written about the discrepancies of sensory distribution shown in anatomical charts. Sensory overlap to any given area has also concerned the clinician in attempting to interpret findings. Practically, in testing these patients the following facts will prove to aid in correct diagnosis. The outer side of the lower leg as well as the outer side of the ankle and foot can be considered the area supplied by the 1st and 2d sacral nerves. If the sensory changes are limited to this area the herniated nucleus will generally

be found at the lumbosacral interspace. If in addition, there are sensory losses on the inner side of the foot, from toe to heel, which is the area supplied by the 5th lumbar, the nucleus will be found at the fourth-fifth lumbar interspace. Since the majority of herniations occur at the fourth-fifth lumbar interspace (apparently quite irrespective of the orthopedic instability being oftenest at the lumbosacral level) sensory changes will usually involve the 5th lumbar, 1st and 2d sacral skin areas.

Straight leg raising, as is generally known, is apt to be limited on the painful side. The sciatic nerve is more or less tender to pressure all the way from the sciatic notch to the popliteal space. Increase of sciatic pain with coughing or sneezing may exist. This is not particularly diagnostic as some cauda equina tumors produce this complaint too.

SPECIAL TESTS

X-ray. While the x-ray films are of great importance to the orthopedic surgeon, they are of less help to the neurological surgeon in these cases. It has already been shown in the literature that a narrowed intervertebral space is not a reliable guide to either the presence or the level of a herniated nucleus. The herniation can occur with a normal intervertebral space. This was generally true in this combined group II. The orthopedic instability and narrowed intervertebral space were generally at the lumbosacral level whereas the herniated nucleus was usually found at the fourth-fifth lumbar interspace. As previously stated, sensory testing was found to be the reliable guide to the level of the herniated nucleus, regardless of the narrowed space.

Lumbar puncture. This test is routinely carried out in all cases. It is carried out not because the results are diagnostic for herniated nucleus but because it occasionally helps to reveal spinal cord tumor instead. There is practically no risk and little discomfort to the test. Therefore there seems no point in omitting it from the preoperative study. The spinal manometric is characteristically normal as would be expected with so small an intraspinal lesion. The average protein reading is 50 milligrams, a slight elevation above normal. With convincing neurological signs of a herniated nucleus and a normal protein, the latter should not modify the diagnosis. There does not seem to be an entirely satisfactory explanation for the mild elevation in spinal fluid protein produced by a herniated nucleus. It is a comparatively small lesion within the large lumbar canal.

Lipiodol. As already stated, lipiodol has not been used in this hospital for making the diagnosis of herniated nucleus. It has not been found necessary. I am aware of the many splendid special studies of its use in this connection, among them being those of Camp, Hampton and Robinson, Bell and Spurling.

There seems to me to be real objections to the use of lipiodol. There is a fairly general tendency to accept a negative lipiodol report, despite definite neurological signs, as proof that the lesion is not present. I have operated upon a number of patients for a herniated nucleus who had been rejected for operation elsewhere, because of a negative lipiodol report. In each such case definite signs of a herniated nucleus were present, and the lesion was found at operation. A positive lipiodol study is excellent proof of the existence of a herniated nucleus. A negative lipiodol study is not reliable proof of its absence. Unless the surgeon is willing to operate upon the basis of real neurological signs, many patients with a negative lipiodol report will continue to have their herniated nucleus and the pain it produces.

Lipiodol, despite some reports to the contrary, is not entirely harmless. I have on several occasions operated upon patients who had had lipiodol injected into the spinal canal a long time before. In each instance the nerves of the cauda equina were involved in a heavy connective tissue scar. Throughout the latter, as dissection was carried out, numerous collections of the lipiodol were opened into. It seems obvious that in some patients, lipiodol, if left in the lumbar sac over a period of years will cause scarring and trouble. Present methods for the removal of lipiodol are not entirely satisfactory. Removal of much of the lipiodol can be accomplished. A good deal still remains, as anyone can see who will look at an x-ray picture taken after such a procedure. Lipiodol, once in the lumbar sac, can sometimes travel quite far, along the individual nerves; Dyke and Deery, and Capener. There are occasional cases involving neurosurgical diagnosis in which, all other means failing, lipiodol does seem indicated. In such, I use it without hesitation, but with regret.

Attempts to demonstrate the herniated nucleus by the subarachnoid injection of air and other gases were given a fair trial some time ago in this hospital. Myelography was then abandoned as being unsatisfactory. A negative myelogram is even less reliable data than a negative lipiodol test.

OPERATIVE TREATMENT

When both a surgically unstable joint and a herniated nucleus are diagnosed in this hospital, both operations are carried out at the same time.

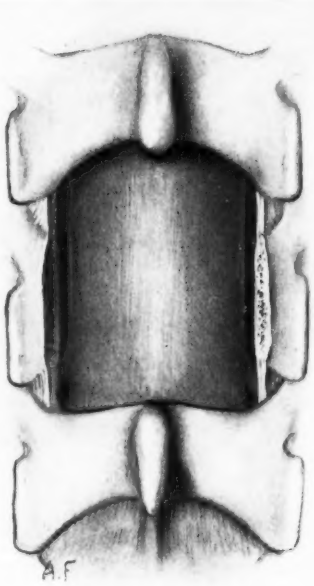

Fig. 1.

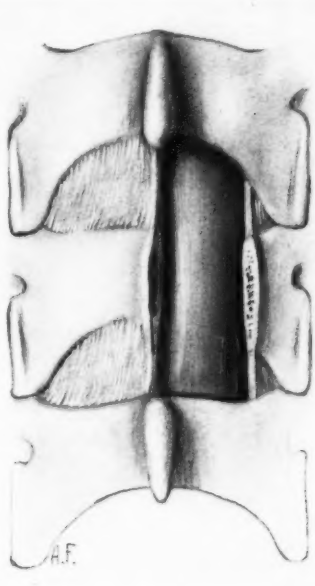

Fig. 2.

This is the logical procedure from all possible viewpoints. It involves only one hospitalization and one operation for the patient. There is no increase in operative risk in combining the orthopedic and neurosurgical procedures. The mortality in the first one hundred such cases in this hospital was zero. The present greatly simplified neurosurgical procedure for removal of the herniated nucleus does not offer any threat to the chances of successful fusion. Those who have had much experience in operating through a well healed fusion to get at and remove a previously overlooked herniated nucleus will appreciate the difficulties involved if the herniation is not removed at the first operation. Whenever a herniated nucleus is diagnosed before a fusion operation it should always be dealt with at the time of fusion. We have in this hospital more recently come to exploring for herniated nucleus at the time of fusion in nucleus suspect cases. When a herniated nucleus has not been definitely diagnosed but is suspected, exploration is made. We are finding a surprising number in this way. The neurosurgical exploration is sufficiently simple during a fusion operation so that we now feel it indicated in these suspected cases.

Laminectomy. Most orthopedic surgeons are aware of the neurosurgical procedure for removal of herniated nucleus now carried out in the vast majority of cases. The laminectomy of 10 years ago for this condition has been greatly modified. Certain of the objections held by orthopedic surgeons to the laminectomy as formerly carried out cannot be justified now. The evolution of the laminectomy for herniated nucleus should be of interest to all who come into contact with these patients.

The earlier operations were comparatively formidable procedures. Several pairs of laminae were often removed. The dura was opened and the nerves of the cauda equina retracted and search made for the characteristic bulge under the ventral dura caused by the herniation. When found, the ventral dura was opened and the lesion was removed.

With increasing knowledge and experience came the realization that the lateral position in the spinal canal of most herniations, made an extradural approach logical. It then became usual to expose the lesion by the removal of one pair of laminae (Fig. 1) and without opening the dura. Hemilaminectomy (Fig. 2) logically followed.

Even the sacrifice of this amount of bone was found to be unnecessary in most cases, as the herniated nucleus lies at the interspace level rather

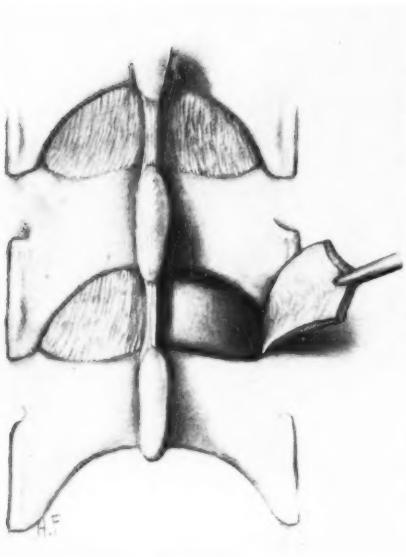

Fig. 3.

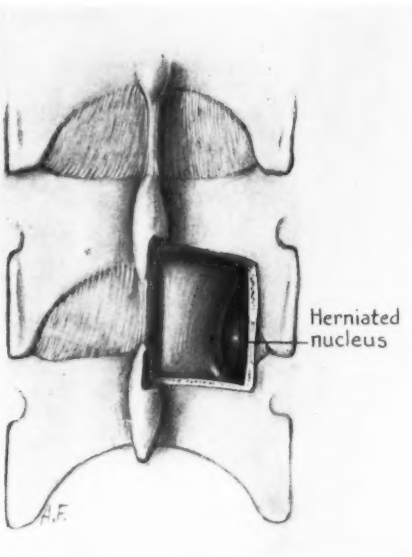

Fig. 4.

than under the lamina. The present procedure in most cases consists of exposure and removal of the herniated nucleus through the interlaminal space with the sacrifice of little or no bone at all. Figure 3 shows removal of the ligamentum flavum on one side only.[1] After the ligament is removed or reflected, the herniation can generally be felt even before it is seen. Figure 4 is a composite sketch showing a small amount of bone removed from both laminal edges. Removal of bone from one laminal edge is oftener sufficient and in many cases removal of the nucleus can be carried out without any bone being removed. Thus the present operation is a comparatively simple procedure carried out between the laminae. The interlaminal space is kept at its maximum width during the procedure by having the patient's hips flexed and the legs down.

TYPES OF HERNIATED NUCLEUS

Type I. The most common type of herniated nucleus found at operation is a small round to oval mass, still covered by the overlying lateral portion of the posterior longitudinal ligament. It can generally be felt with the forceps before it is seen. It has a characteristic rubbery resistance to touch. Overlying the lesion is the spinal dura and the involved nerve root. The latter is curved upward, pushed laterally, and is generally somewhat flattened from the pressure of the lesion beneath. As first encountered the most prominent part of the herniated nucleus generally presents in the angle formed by the nerve root and its junction with the spinal dura as a whole. It is a natural temptation to attack the lesion in this angle. This should never be done. This angle contains more or less fatty tissue, often several small veins and is entirely too crowded to work in. Injury to the nerve is apt to result if the herniation is approached in this angle. The safest and actually the quickest method of exposing the herniated nucleus, is to retract and coax the nerve root medially, over the prominence of the herniation.

With the unopened spinal dura and the nerve root both retracted medially the lesion is exposed lateral to the nerve root. With incision of the overlying posterior longitudinal ligament the nuclear material is readily removed with clamp, forceps or curette. There does not seem to be any real reason for curetting deeply within the substance of the intervertebral disc. To a certain extent it seems true that the shorter the history of the patient, the softer the nuclear material. Firmer, tougher nuclear material, often permitting removal in one piece with a clamp, is more often encountered in patients with a longer history of sciatic pain.

[1]These illustrations show the bilateral exposure of the spine as seen in the combined operations. In uncomplicated herniated nucleus without the need of fusion, retraction of only one side of the back muscles is needed.

Type II. Less frequent, though indeed common enough, is the herniated nucleus that has already forced its way partly or wholly through the posterior longitudinal ligament. It lies directly under the nerve root, almost free within the spinal canal except for a small portion beneath the ligament. This type of herniated nucleus can generally be picked up and removed in one piece with a minimum of exposure and effort. It is very easy to see and remove.

Type III. This is the least common but the most discussed. This small, almost flat lesion, is often missed by some. It is pronounced no herniation at all and left untouched by others. There is a question in the minds of many who are shown this lesion in the operating room, whether it is really a herniation at all. Compression of the nerve root seems negligible and the lesion is often almost flat. This type is small, flat, inconspicuous, and very easily missed.

The question as to whether or not this is a real herniation can be answered quite definitely. Removal of the lesion in the usual manner does cure the patient's sciatic pain. Laboratory study of the specimen proves it to be typical nuclear material. Finally, in such cases exploration of the next interspace will invariably prove negative for another herniated nucleus.

Why such a small flat lesion can produce its signs and symptoms is a more difficult question. The probable explanation seems to be that some of these lesions can and do vary in size, with different positions of the patient. We have hyperextended some of the patients as Love and Walsh have done, while the lesion has been under direct observation. I have seen enough evidence in some to believe that variations in size are possible. Ordinarily we do not take the time now to try this test. The rubbery resistance of even these small flat lesions is quite characteristic and very different from the feeling of a normal posterior longitudinal ligament with a normal intervertebral disc beneath. Unconvincing though this small type of herniation may appear in the operating room it is never a mistake to remove it.

THE INTERVERTEBRAL FORAMEN

Surgeons dealing with sciatic pain have long been aware of the importance of the intervertebral foramen: Naffziger, Inman, and Saunders; Ghormley and Kirklin; Hadley (12, 13); Hart; Mitchell; Ghormley and Wesson; Williams and Yglesias; and Williams. The intimate relation at the region of the foramen, of the posterior longitudinal ligament, the ligamentum flavum, and a herniated nucleus, is important to keep in mind. There is often, particularly in this combined group with an orthopedic problem, more or less thickening of the ligamentum flavum anyway. Added to this is the presence of a herniated nucleus and more or less engorgement and swelling of the involved nerve. It can be well imagined that the foramen is quite crowded. Relatively small herniations occurring far laterally can produce much crowding of the nerve. After removal of a herniated nucleus it is always worth while to curette away thickened ligamentum flavum tissue in the region of the foramen. A probe should finally be passed out along the nerve through the foramen to make more certain that no removable obstruction exists.

PROBLEMS IN TREATMENT

Fusion operations and "sciatica." The controversial points existing on this question are numerous. From the neurosurgical viewpoint certain remarks seem justified. The question of fusion for low back pain and sciatica is of course a purely orthopedic problem. It is urged, however, that the orthopedic writer should define the general term "sciatica." If the cures of sciatica by fusion reported in the literature mean cures of sciatic pain (sciatic neuralgia), no question can be raised from the neurosurgical viewpoint. If, however, the term "sciatica" implies the presence of a herniated nucleus, a major question can be raised. As emphasized earlier, the diagnosis of a herniated nucleus is made on the basis of convincing signs of the sciatic neuritis caused by the pressure of the herniated nucleus. Sciatica, sciatic neuralgia, or sciatic pain are no convincing proof of the presence of a herniated nucleus. The reports of cures of sciatica in the literature do not definitely state that herniated nucleus pulposus is present. The implication, however, is often that it is. Completely lacking in such reports is any detailed neurological data in proof that a herniated nucleus is present. It is not questioned that sciatic neuralgia of various types responds to appropriate orthopedic measures as reported in the literature. The often raised question as to whether fusion alone can relieve sciatic pain is a very different question therefore from whether fusion alone can relieve the symptoms of a herniated nucleus. We all see cases of sciatic neuralgia in which there is no suspicion of herniated nucleus.

Fusion for herniated nucleus. Will the immobilization provided by fusion relieve the patient with a real herniated nucleus? The number of patients coming to this hospital for relief of herniated nucleus who have previously received a fusion

points otherwise. Relief of their sciatic neuralgia and recovery from sciatic neuritis come only after the herniated nucleus is removed.

The appearance of the flattened, tense nerve stretched over the usual herniation, seen in the operating room, suggests that no operation other than removal of the mass beneath could give relief to that nerve. It is difficult to see how fusion alone can provide any relief to such a nerve. Removal of the herniated nucleus at the time of fusion is a relatively simple procedure. Removal later through a solid fusion is quite difficult. When herniated nucleus has been definitely diagnosed, fusion alone is incorrect and almost surely will mean further surgery for the patient later.

Fasciotomy. The number of patients showing definite evidence of a herniated nucleus who have previously received a fasciotomy operation calls for comment. In these patients the fasciotomy had failed to relieve their sciatic pain. It is difficult to imagine why that operation should relieve the pain caused by a herniated nucleus nor was the operation designed for this condition. The fasciotomy may have been carried out before convincing signs of herniated nucleus were present. In others it is obvious that neurological signs, present for long, had been overlooked. A neurological examination should be called for to rule out herniated nucleus before fasciotomy operations.

CONCLUSION

In addition to uncomplicated herniation of the nucleus pulposus it is apparent that this condition does occur as a complication of low back instability. A more general recognition of such combined problems than exists at present is needed. Adequate handling of such combined problems requires the services and close co-operation of both orthopedic and neurosurgical specialties. Such patients require combined operations to solve their problem adequately. It is believed that when both conditions exist, they both must be recognized and treated together to insure the speediest possible recovery.

REFERENCES

1. Bell, J. C., and Spurling, R. G. Radiology, 1938, 31: 473–480.
2. Bradford, F. K., and Spurling, R. G. The Intervertebral Disc. Baltimore, Md.: Charles C. Thomas, 1941.
3. Camp, J. D. Proc. Mayo Clin., 1937, 12: 373–377.
4. Capener, N. Proc. R. Soc. M., Lond., 1937, 30: 1262–1263.
5. Danforth, M. S., and Wilson, P. D. J. Bone Surg., 1925, 7: 109–160.
6. Deery, E. M. Textbook of Pathology; Delafield & Prudden. 16th ed., p. 1222. Baltimore: William Wood & Co., 1936.
7. Dyke, C. G., and Deery, E. M. Bull. Neur. Inst. N. York., 1931, 1: 593–599.
8. Ghormley, R. K. J. Am. M. Ass., 1933, 101: 1773–1777.
9. Ghormley, R. K., and Kirklin, B. R. Am. J. Roentg., 1934, 31: 173–176.
10. Ghormley, R. K., and Wesson, H. R. South. M. J., 1937, 30: 806–811.
11. Goldthwaite, J. E. Boston M. & S.J., 1911, 164: 365–372.
12. Hadley, L. A. J. Bone Surg., 1936, 18: 428–433.
13. Idem. J. Am. M. Ass., 1938, 110: 275–278.
14. Hampton, A. O., and Robinson, J. M. Am. J. Roentg., 1938, 36: 782–803.
15. Hart, V. L. J. Lancet, 1935, 55: 309–313.
16. Love, J. G., and Walsh, M. N. J. Am. M. Ass., 1938, 111: 396–400.
17. Mitchell, C. L. J. Bone Surg., 1934, 16: 706–708.
18. Mixter, W. J. Ann. Surg., 1937, 106: 777–787.
19. Mixter, W. J., and Barr, J. S. N. England J. M. 1934, 211: 210–215.
20. Naffziger, H. G., Inman, V., and Saunders, J. B. de C. M. Surg. Gyn., Obst., 1938, 66: 288–299.
21. Smith, Alan DeForest. Surg. Clin. N. America, 1939, 19: 475–491.
22. Spurling, R. G., and Bradford, F. K. J. Med., 1939, 19: 598–605.
23. Williams, P. C. J. Bone Surg., 1937, 19: 343–363.
24. Williams, P. G., and Yglesias, L. J. Bone Surg., 1933, 15: 579–590.

POSTERIOR HORN LESIONS IN MENISCAL INJURY

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INJURIES to the menisci have long been recognized as a cause of chronic disability in the knee. Excision of these bodies has classically been practiced as the treatment of choice. However, among those fortunate enough to see a relatively large number of cases, there has been dissatisfaction in certain of the end-results. A variety of incisions has been developed. These are designed to permit better exposure, to make removal of the meniscus easier as well as to make possible inspection of the joint for associated pathology. These incisions, together with variations in postoperative care, that is, splintage versus no splintage, early versus delayed motion, early versus late weight-bearing, etc., and the multiplicity of types of postoperative physiotherapy, attest the fact that perfection has not yet been achieved. The following discussion deals with a phase of this problem which has not been sufficiently emphasized; namely, the treatment of lesions of the posterior part of the meniscus.

This study is based on 110 cases in which patients were operated upon at the Letterman General Hospital from January, 1941, to November, 1942. It has been marked by an increasing appreciation of the involvement of the posterior element of the meniscus and a swing from the conservative excision of the meniscus to its excision *in toto*. Posterior lesions of the meniscus were frequent. They were found both alone and in association with lacerations in other locations in the cartilage. Since they could be discovered only by inspection, total removal became the procedure of choice. These cases, for the most part, were chronic, and symptoms had been present from several months to many years. The majority were military personnel in the 20 to 30 year age group, although a few were between 30 and 40. The latter were usually old cases with repeated episodes of locking, recent flare-ups of old quiescent injuries which had been aggravated in the course of vigorous physical and tactical training, and occasionally a case of recent injury.

The cases may be summarized as follows: The total number of cases was 110, the number of cartilages studied, 112. Resection of the entire meniscus was done in 81 cases; resection of the anterior two-thirds in 31 cases; resection of the medial meniscus in 98 cases; resection of the lateral meniscus in 10 cases of which 7 were done for tears and 3 for cysts; removal of both internal and external cartilage was done in 2 cases.

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INDICATIONS FOR OPERATION

Group 1. Total excision of the meniscus is mandatory in the presence of the following conditions: (a) posterior bucket-handle tear, present in 10 cases; (b) avulsion of the posterior third, present in 6 cases; (c) posterior angle tears, present in 5 cases; (d) complete avulsion of the meniscus except at the anterior and posterior attachments, present in 4 cases; (e) bucket-handle tears with separation in the mid-portion, present in 3 cases; (f) separate tears of both anterior and posterior horns, present in 1 case; (g) excision of the posterior third of the meniscus and popliteal tendon (reoperated upon), 1 case; (h) cysts of the lateral meniscus present in 3 cases of which 2 cysts were in lateral position and 1 was in the posterior pole.

Total removal of the meniscus is absolutely necessary if the patient is to be relieved of symptoms arising from lesions such as those just enumerated. The persistence of tears, tabs, or other incongruities often results in residual symptoms of meniscus injury, even though locking has been eliminated by partial resection. Many of these lesions cannot be visualized at operation either directly, by traction on the cartilage from the anterior incision, or by the use of the auxiliary posterior incision. In the latter, it is difficult to see the meniscal surfaces which are in contact with the articular cartilage. Luxation of the meniscus into the intercondylar notch as described by Bristow is not a satisfactory test for posterior meniscal pathological lesions, since many of the angle tears and splits in the posterior cartilage are not discovered by this procedure (Fig. 3). Certainly, a large proportion of tears are overlooked if the entire meniscus is not removed, especially in those cases in which the posterior lesion is not diagnosed before operation. Only total excision and inspection of the specimen can be relied upon.

Group 2. Total excision of the meniscus should usually be done in the precence of: (a) bucket-handle tears, found in 33 cases of our series; (b) tears

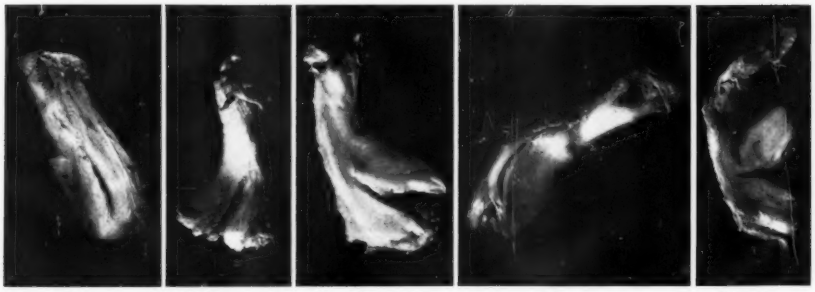

Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5.

Fig. 1. An early longitudinal split in the body of the posterior cartilage.

Fig. 2. A split has extended to the posterior pole with slight displacement.

Figs. 3 and 4. Splits with pronounced displacement. (The tear in the mid-portion of the meniscus in Figure 4 is an artefact.)

Fig. 5. A posterior split which has been torn loose from the posterior pole so that the central portion forms a tab with its attachment in the middle third of the meniscus.

of the middle one-third, found in 2 cases; and (c) hypermobile menisci, found in 5 cases.

There is little doubt that in a number of cases in this second group there will be a considerable portion of the disturbing element left in the joint if only the anterior two-thirds of the cartilage and its associated bucket-handle tears are removed. This is particularly true in cases of long standing injuries in which multiple lesions in different stages of healing are present. It is impossible to tell which case has a simple, single, tear. The arthritis found in joints with old meniscal lesions is often the result of such an oversight. Tears in the middle third fall in the same category. Hypermobile menisci should be totally removed because they usually reveal degenerative changes extending throughout, which form the basis of future tears, and because it cannot be determined by inspection through the operative incision alone, that there is not a tear in some portion. Elderly, sedentary patients form the exception to this view.

Group 3. Total excision is controversial in the case of lesions limited apparently to the anterior half of the meniscus, such as avulsion of the anterior attachment, avulsions from the coronary ligament, splits, and tabs. Such lesions were found in 37 of our cases. Visualization cannot always be relied upon since it is shown by one case mentioned in group 1 that isolated tears in both the anterior and posterior portions may exist simultaneously. Good judgment on the part of the surgeon is essential in these cases. Some surgeons may approve of the removal of only the anterior two-thirds of the meniscus if trauma does not appear extensive and is localized to the most anterior aspect of the joint. However, in the light of our experience we are of the opinion that complete removal of the meniscus is necessary, since such lesions as represented in Figures 1 to 4 clearly demonstrate how a hidden pathological process may exist in the posterior element. Complete excision is the logical course if there is considerable evidence of trauma or the tear extends past the anterior third.

Group 4. In this group of 2 cases no pathological process was discovered. When no pathological lesion is visualized, it is best to excise the meniscus on the basis of symptoms alone. The frequent discovery of tears in the posterior horn after total excision in cases in which there was no gross change on examination through the anterior approach is the basis of this concept. Typical examples of this type of lesion are shown in Figures 1 to 4. In our opinion, it is better in a symptomatic knee to excise a normal cartilage totally rather than to risk overlooking a posterior tear. It is generally recognized that such a procedure is not attended by any more residual disability than occurs with simple arthrotomy.

In summary, we believe that the entire meniscus should be removed in all cases in which the clinical examination has led to a diagnosis of meniscal injury. This includes those cases in which arthrotomy performed for other conditions such as osteochondritis dissecans, etc., reveals unsuspected coexisting lesions of the semilunar cartilage. Residual symptoms frequently arise from degenerative changes in the articular cartilage and synovia which follow incomplete removal of lacerated meniscal fragments.

DIAGNOSIS

There are two diagnostic aids in the preoperative examination for derangement of the pos-

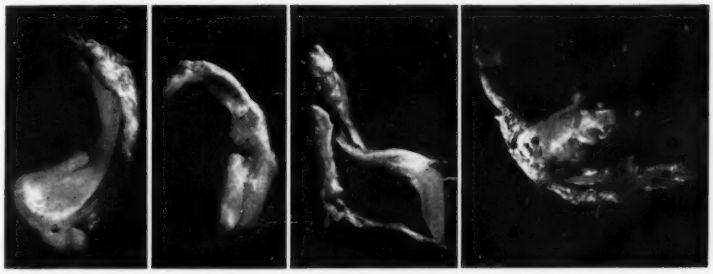

Fig. 6. Fig. 7. Fig. 8. Fig. 9.

Fig. 6. A posterior angle tear in a relatively early stage. This type will not give a positive posterior click sign. Note that the tear originates from the central border tending to refute the hypothesis of Bristow that tears in the menisci are all primarily longitudinal.

Fig. 7. A later healing stage of the posterior angle tear.

Fig. 8. Complete bucket-handle tear, including the whole posterior horn. Note the secondary pathological lesion in outer portion.

Fig. 9. An old injury of the meniscus with multiple tears in different stages of healing.

terior meniscal elements: first, tenderness posterior to the collateral ligament, and second, the presence of a posterior click. The latter requires some explanation. Its presence has been recognized for several decades, although not generally employed in routine orthopedic examination. In his classical monograph on internal derangements of the knee, Fischer states: "Displacement of the posterior horn of the external semilunar cartilage, by no means a rare occurrence, is probably due to internal rotation of the femur on the fixed tibia, followed by, or combined with, violent flexion. It is one of the causes of the peculiar condition known as clicking or snapping knee, the last 20 or 30 degrees of extension being accompanied by a click and jerk forward of the tibia." In reference to the medial meniscus, McMurray states: ". . . . as the leg is brought from the position of acute flexion to full extension, a click may appear in the joint but usually the click is so slight that no notice is taken of it." Watson-Jones has re-emphasized the value of this test in his recent textbook.

The posterior click test is accomplished as follows: With the patient lying on his back and the examiner standing by his side, the knee is placed in full flexion. One hand locates the joint line and the other firmly grasps the foot. The tibia is first internally and externally rotated, and then abducted and adducted. Following this, it is forced into external rotation and extended, and then placed in internal rotation and extended. At some time during the course of this maneuver, a click is felt and frequently heard in the joint line posterior to the collateral ligament. This must be differentiated from the crepitant, grating sensation, of a synovitis. The patient will describe the sensation as a "slipping" or "pop" in the middle of the joint. Frequently, when the click cannot be heard audibly, it can be demonstrated by the stethoscope. The click is usually best demonstrated in the medial meniscus on external rotation and extension from the fully flexed position, and in the lateral meniscus by internal rotation and extension. No correlation between the degree of extension and the position of the tear could be demonstrated.

In 71 cases in which this test was made a part of the routine examination, it was found to exist in 15 (21%). In each instance, a lesion was found in the posterior horn of the cartilage. It may be said therefore that in this limited experience the "posterior click" is significant of posterior horn lesion. This does not mean that there is no other pathology in the meniscus, but simply that the posterior segment is involved. This sign was found in association with complete bucket-handle tears, and in bucket-handle tears in which there were secondary posterior splits and rupture of the mid-portion of the bucket-handle fragment, as well as complete avulsion of the posterior horn from the coronary ligament. It was also present in one case of bucket-handle tear in which there were no other clinical signs present. The fact should be stressed, however, that posterior horn lesions can exist in cases in which no "posterior click" is elicited.

RATIONALE OF SURGICAL TECHNIQUE

The short anterior-medial or anterior-lateral incision is the approach of choice for removal of the entire meniscus. It can easily be extended into the long parapatellar utility incision if associated pathological changes are found in the joint. There is no objection to the use of any of the

specialized approaches by those who can uniformly make an exact diagnosis of isolated meniscal lesion.

The problem of freeing the posterior portion of the meniscus frequently arises. In the technique used by the writers, the knee is placed over the end of the operating table flexed to 90 degrees. In the "relaxed" type of knee, the excision may usually be done by dissection with knife and scissors with little difficulty. Removal is frequently facilitated by freeing the posterior attachment through the intercondylar notch so that the posterior rim of the meniscus is exposed when it is drawn to the side of the joint under moderate tension. Gentleness is encouraged throughout, and avulsion of the posterior portion by the blind use of strong traction is to be discouraged.

If the knee is "tight," there are two alternate methods of freeing the posterior elements. One is exposure through the Henderson incision. This enters the posterior compartment between the hamstrings and the posterior aspect of the joint. The second is the use of the tenotomy knife subcutaneously to free the posterior rim. It is performed as follows: The knife is inserted at the posterior medial or lateral aspect of the joint one-half inch above the articular surface of the tibia to insure that the blade will enter above the level of the meniscus. With traction on the cartilage, the meniscus-synovial junction is determined by placing the blade on the meniscus and moving it posteriorly until it drops in the soft synovial tissue. The cartilage is then separated from the synovia at this point and luxated into the intercondylar notch where it is amputated. This method requires a certain degree of proficiency in that it is blind. It is not easily accomplished by the inexperienced. In only 4 of 81 cases was it necessary to use the Henderson approach. The use of the Lowe-Breck and Dunlap knives, although not employed by the writers, may be of considerable advantage in the hands of the experienced.

The anterior-medial incision is used in cases of reoperation for posterior horn lesion. This is done since in practically all cases another surgeon has performed the first operation. Exact records are usually not available and associated pathological lesions can be determined only by visualization in most instances. Inspection includes not only the usual search for changes in the articular cartilage and synovia, but also special situations. In one case, for example, only the anterior third of the meniscus had been resected, leaving the fragmented posterior two-thirds in its usual position. In another case, the bursa between the tibial collateral ligament and synovia had become chronically irritated although the meniscus had been previously excised. With swelling, the synovia with its thickened fibrous edge had been forced between the joint surfaces to produce a pseudo-locking. In a third instance in which a lateral meniscus had been previously excised in its anterior two-thirds, the popliteal tendon had luxated into the joint at the posterior lateral angle where it is usually in contact with the meniscus. Excision of the cartilage and the popliteus tendon from its point of origin on the lateral femoral condyle to the posterior joint line gave relief of symptoms. Lastly, the fibrocartilage, which is formed from the synovial edge following surgical removal of the cartilage may itself be a cause of disability, especially if it has been formed from redundant synovia.

CONCLUSIONS

1. Lesions of the posterior meniscus frequently exist both alone and in association with tears of the rest of the cartilage.

2. The presence of a "posterior click" immediately behind the collateral ligament is evidence of posterior horn pathology.

3. Absence of this sign does not eliminate posterior horn pathology.

4. The entire cartilage should be removed routinely in all cases.

5. The technique and rationale of surgical excision of the meniscus as practiced by the writers is presented.

REFERENCES

1. Bristow, W. R. J. Bone Surg., 1935, 17: 605.
2. Dunlap, Knox. J. Bone Surg., 1942, 24: 929.
3. Fischer, A. G. T. Internal Derangements of the Knee. New York: The Macmillan Co., 1924.
4. Lowe, F. A., and Breck, L. W. J. Bone Surg., 1938, 20: 220.
5. McMurray, T. P. The diagnosis of internal derangements of the knee. Robert Jones Birthday Volume. New York: Oxford University Press, 1928.
6. Smith, S. A. Sidelights on knee joint surgery. Robert Jones Birthday Volume. New York: Oxford University Press, 1928.
7. Watson-Jones, R. Fractures and Other Bone and Joint Injuries. Baltimore: The Williams & Wilkins Co., 1941.

TEN YEARS' EXPERIENCE WITH RIBBON GUT IN UROLOGICAL SURGERY

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IT is just 10 years ago that Mr. William P. Didusch, the great urological artist, suggested the use of untwisted catgut as a material for the repair of wounds in the kidney. In experiments upon animals this material proved so successful that it was promptly tried on human beings, and its use here was so satisfactory that it is now employed by us universally in many types of operations upon various organs. We have found it a most important addition to our armamentarium wherever we deal with delicate tissues.

Our animal experiments quickly proved that properly moistened ribbon gut (which contains one sixth the amount of catgut in a No. 2 catgut ligature) could be tied firmly without breaking or tearing, and that it did not cut through delicate or friable tissues. Also, it had the marvelous property of permitting fibroblasts to grow between its fibers so that, as the latter were absorbed, the fibroblasts replaced the entire structure, as shown in many of our microscopic specimens. This is a logical thing to happen because this material is an animal membrane, and hundreds of our specimens show that fibroblasts never fail to replace the ribbon gut (Figs. 1 to 4).

RIBBON GUT IN THE REPAIR OF KIDNEY WOUNDS

Nephrostomy. We experimented first with the use of ribbon gut in the repair of kidney wounds. The material used consisted of flat ribbons of untwisted gut, 25 to 65 centimeters long, 1.8 to 2.0 centimeters wide, and of the thickness of fine rice paper. The gut is sterilized by heat in the usual type of aseptic catgut tube, and is unaffected by age, climate, or light. Before it is used, ribbon gut should be immersed in warm sterile water or saline solution for about 10 minutes to render it soft and pliable. Unlike the spirally twisted strands of surgical catgut which lose tensile strength by too long an immersion, ribbon gut is not injured by prolonged wetting. In animal experiments it has been used in bands of one half of the standard width (about 0.8 cm.); in operations upon humans the full width has been used. It is tied in the same manner as are ordinary types of catgut, the width of the material does not interfere with adequate knots, and the tape shows a tendency to twist only over a distance of about a centimeter immediately adjacent to the knot.

A series of animal experiments was first carried out upon rabbits, and served to demonstrate the practicality of the method. However, the rabbit's kidney is so small that it was deemed advisable to use larger animals; consequently dogs were used in the second series of experiments, and proved entirely satisfactory. Postmortem specimens of animal kidneys showed conclusively that wounds and incisions repaired in this manner heal perfectly and that there is no destruction of kidney substance such as one sees when needles are passed through cortical tissue in the usual way.

The first nephrostomy upon a human being, in which closure by the ribbon gut technique was used in our department was done on February 15, 1933 for the removal of renal calculi; and nephrostomy with closure by this method has been used by us ever since.

The technique of operation is as follows: The kidney is exposed and mobilized through the usual lumbar incision. When the operation is for the removal of a calculus, the incision into the kidney is usually made in either the upper or the lower pole, preferably on the lateral convex border so as to avoid the vessels as much as possible. Almost any renal stone can be removed through a polar incision, and this type of wound is more easily repaired than a central cortical incision.

With the kidney completely exposed, ribbon gut which has been threaded into the Lowsley ribbon gut needle (a flat, slightly curved, spear pointed needle with cutting edges), is fixed in the proper position by passing it through the fibrous capsule of the kidney on the anterior and posterior surfaces. An incision is then made into the renal cortex between the two capsular straps, hemostasis being secured by manual pressure over the renal pedicle applied by an assistant. The calculus is located and extracted with forceps. A drainage tube is inserted through the wound into the kidney pelvis. A piece of fat is placed in the wound for hemostasis and held in position while

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Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 1. Definite evidence of fibroblasts growing within the tendrils of ribbon gut tied around the kidney.

Fig. 2. Ribbon gut tied around the kidney entirely replaced by fibrous tissue.

Fig. 3. Showing definite evidence of fibroblasts replacing ribbon gut in rectal plication.

Fig. 4. Replacement of ribbon gut by fibroblasts tied around the urethra.

the ends of the ribbon gut are tied over it with just enough pressure to approximate the edges of the wound. The kidney is replaced in the renal fossa; Penrose drains are placed down to the site of the nephrostomy; and the wound is closed in the usual manner, 1 interrupted dermal suture of silk holding the nephrostomy tube in place at the posterior angle of the wound (Fig. 5).

To date, 208 nephrostomies have been performed at the Brady Foundation in the New York Hospital, by the fat and ribbon-gut method of closure. Bleeding has occurred in 2 cases, but in all the others the nephrostomy wound healed promptly and well, with no complications.

Calyceal Resection. During the past 7 years, at the Brady Foundation, selected cases of primary and recurrent calyceal stones have been treated by resection of the stone containing calyx (usually the inferior calyx) together with a wedge-shaped piece of kidney parenchyma, repair of the kidney wound being by the ribbon-gut-fat technique. In 1940, Twinem reported 10 clinical cases, and in September, 1941, Yunck and Forsythe presented further follow-up on these 10 cases, as well as 9 new cases and data obtained from experimental calyceal resections performed on 13 dog kidneys. The 19 operations upon humans resulted in 16 cures and 3 failures. The 16 cured patients all showed prompt healing and minimal infection. Even though, in several cases, a rather large wedge of tissue was removed, there was little decrease in kidney function, as shown by a comparison of the preoperative and postoperative urea and phenolsulfonphthalein determinations.

The calyceal resection is performed as follows: The kidney is exposed through the usual lumbar incision and carefully delivered, the ureter, pelvis, and renal pedicle being gently freed from the surrounding areolar tissue. A wedge-shaped section of cortical and medullary tissue, containing the involved calyx and the stone, is removed in a radial manner in order that the interlobular blood vessels in the remaining parenchyma will be injured as little as possible. The surgical defect is approximated over a small piece of fat by ribbon gut sutures placed through the fibrous capsule in the manner just described (for nephrostomy). A large nephrostomy tube is placed in the renal pelvis, and a No. 8 or 9 F. splinting ureteral catheter is bluntly inserted through a separate nephrostomy opening, approximation by suture usually being unnecessary. The wound is closed in layers with drainage. The ureteral catheter is removed at the end of a week, and the nephrostomy tube 3 to 5 days later. The latter is irrigated only when necessary to secure good drainage.

Heminephrectomy. We have also frequently performed heminephrectomy with closure of the wound as here described. The efficacy of this method has made it possible to remove cysts, as well as the diseased half of a horseshoe kidney, or the diseased portion of either an anatomically normal or a double kidney (except in cases of tumor or tuberculosis).

In an anatomically normal kidney, we perform heminephrectomy as follows: After the kidney has been exposed and delivered, the line of incision is decided upon. Ribbon gut is then placed through

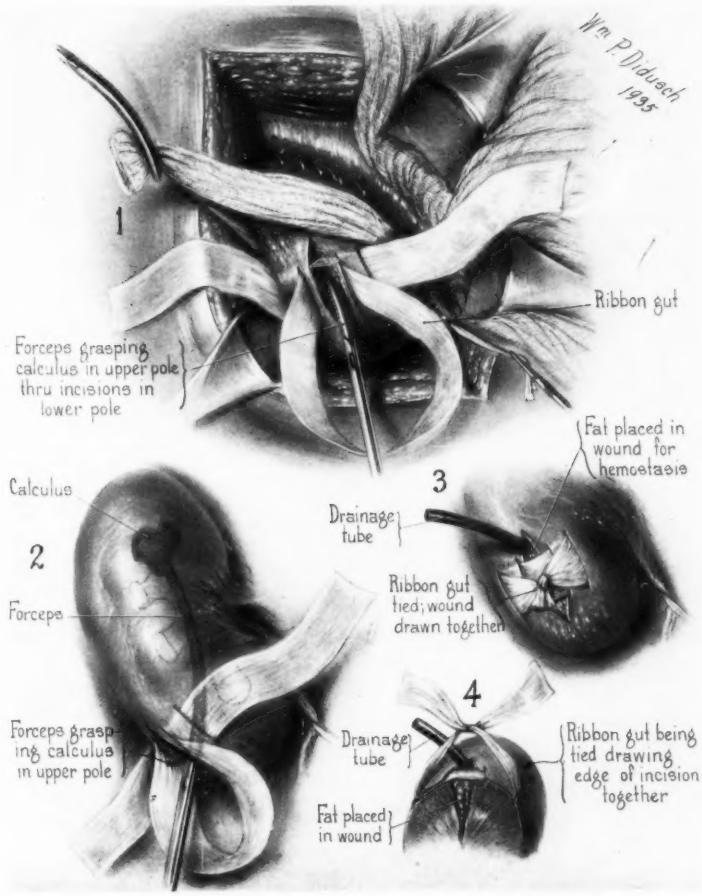

Fig. 5. Nephrostomy by the ribbon gut method. 1, One calculus has been removed from the lower pole and a second is being extracted from the upper pole through the lower pole incision. Ribbon gut has been placed in position through the fibrous capsule of the lower pole. The upper pole is bound down by adhesions from a previous operation. 2, Transparent view, showing the forceps grasping the calculus in the upper pole. 3, A drainage tube has been placed in position, a pad of fat inserted in the wound for hemostasis, and the ribbon gut tied over it. 4, The placing of the drainage tube, fat, and ribbon gut. (From *Clinical Urology*, by Lowsley and Kirwin.)

the fibrous capsule, behind the line of incision, on both the anterior and posterior surfaces, and the ends of the gut are tied and left hanging free. The diseased portion of the kidney is excised in such a manner as to leave a shallow V-shaped wound, with the apex of the V toward the center of the organ. Bleeding is controlled by an assistant grasping the pedicle between his thumb and forefinger. A piece of fat is buttered over the cut surface and the ends of the ribbon gut are tied together over it, approximating the edges of the wound and exerting enough pressure to control bleeding but not enough to cause necrosis or tearing of the fibrous capsule. The kidney is replaced in the renal fossa and the wound is closed in the usual manner with drainage.

In a double kidney, the distribution of the vascular supply must be carefully determined since the halves often have separate blood supplies. The site of the heminephrectomy is then

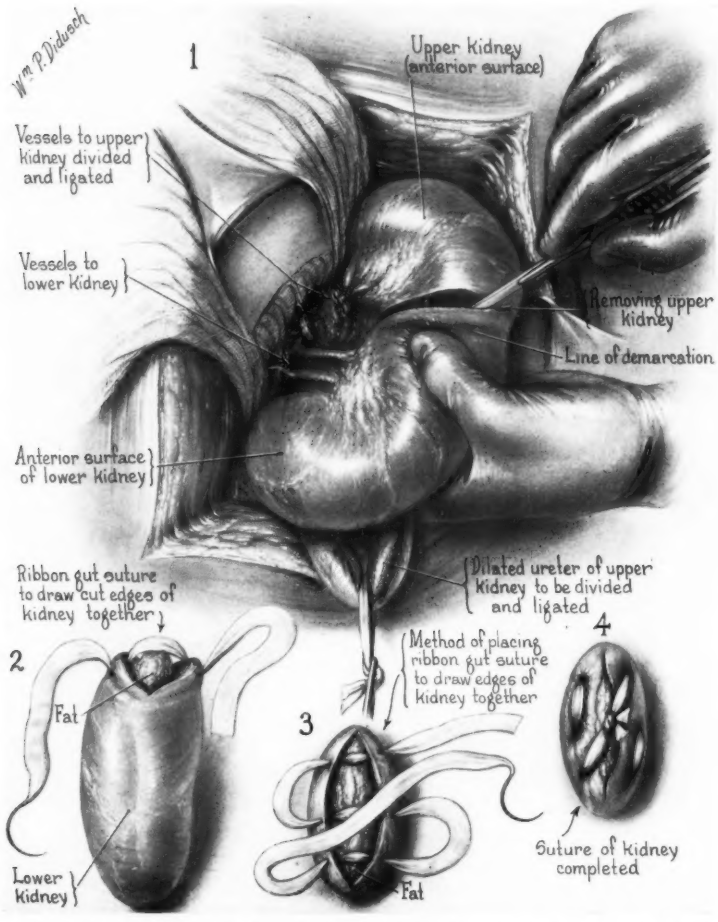
Wm. P. Didusch
1
Upper kidney (anterior surface)
Vessels to upper kidney divided and ligated
Vessels to lower kidney
Removing upper kidney
Line of demarcation
Anterior surface of lower kidney
Ribbon gut suture to draw cut edges of kidney together
Dilated ureter of upper kidney to be divided and ligated
2
Fat
Method of placing ribbon gut suture to draw edges of kidney together
3
4
Suture of kidney completed
Lower kidney
Fat

Fig. 6. Heminephrectomy in a double kidney, with repair by the fat and ribbon gut method. This patient, a 23 year old woman, had a double kidney and ureter on the left side, the ureter of the upper segment emptying into the vaginal vestibule. She had had urinary incontinence since birth. 1, Excising the upper segment of the double kidney after ligation and division of the vessels. The arterial supply to this segment is furnished by a branch from the main renal artery. 2, 3, 4, Steps in the placing of the ribbon gut for repair of the kidney and insertion of fat for hemostasis. (From Lowsley and Conroy (11)).

decided upon; ribbon gut is placed in position through the fibrous capsule, and the diseased segment is excised by making a V-shaped incision into the healthy portion, hemostasis and repair being accomplished as described. About 2 years ago, we thus removed the upper half of a double kidney whose ureter emptied into vaginal vestibule. Excretory urograms a year later showed excellent function of remaining segment (Fig. 6).

In a horseshoe kidney, after exposure of the kidney the aberrant blood vessels (which are always present) are tied off, the upper pole of the diseased half of the kidney is freed, and its ureter is ligated and excised. The isthmus is then identified and freed, and the diseased half of the fused kidney is excised by making a V-shaped incision into the isthmus, its apex being directed toward the sound half. The isthmus is repaired

with ribbon gut placed through the fibrous capsule, a piece of fat being held in the wound while the gut is tied over it. Penrose drains are placed down to the isthmus and the wound is closed in the usual manner.

Repair of Ruptured Kidney. During the past 10 years we have utilized the fat and ribbon gut method of repair in numerous cases of traumatized kidneys—a type of injury that is increasing, due to the growing number of automobile accidents.

Experimental work by various investigators has made possible a better understanding of the mechanism of renal trauma and more effective repair of such injuries. Experimentally and by clinical observation we have proved that great destruction of the kidney may take place without primary rupture of the fibrous capsule. Pulpefaction of much of the cortex may occur without perirenal infiltration of blood or urine until some time after the initial trauma, when ferments released by laceration of the cortex have digested the capsule.

All surgeons recognize the difficulty of selecting the proper cases for immediate operation. Because remote partial or complete destruction of the renal parenchyma, following traumatism, has such grave results in the form of contracted kidney with elevation of blood pressure, stone formation, cystic degeneration, etc., we believe that an exploratory operation under our modern aseptic surgical technique is advisable in most instances. If hematuria continues for more than 24 hours, or if there is no hematuria but there is evidence of extravasation in the excretory urogram, or if there is evidence of hemorrhage as indicated by a tumor in the loin, rigidity, shock, and the findings of blood examination, exploratory operation should be done immediately. Animal experimentation and clinical observation of human cases have convinced us that early operation, evacuation of blood clots, and the production of hemostasis by the fat and ribbon gut method will be followed by less destruction than is the case if the renal traumatism is untreated. Even greatly traumatized kidneys may be successfully repaired by this method.

The kidney is exposed in the usual manner and isolated. Even if the fibrous capsule is intact, the site of the injury can usually be easily seen and felt because the capsule will be elevated over the underlying hematoma. The capsule is opened, blood clots are sponged away, and isolated fragments of lacerated renal parenchyma are removed. Bleeding is controlled by applying bits of fat, which are held in position by ribbon gut passed through the fibrous capsule and tied around the kidney and over the injured area with sufficient pressure to control the hemorrhage. A drainage tube is inserted into the renal pelvis before the ends of the gut are tied; Penrose drains are placed around the kidney, and the wound is closed in the customary manner (Fig. 7).

From examining the kidneys of experimental animals at varying lengths of time after trauma of different degrees had been inflicted upon them, it was found that in no case in which the renal capsule was opened and bleeding was stopped by fat held in place by ribbon-gut sutures, was a kidney destroyed. In even the most extensive injuries, the kidney, observed microscopically, showed actively functioning tubules and glomeruli right at the edge of the reparative scar tissue. This would seem to indicate that the only damage sustained by the renal cortex was that due to the original traumatism, and that there was no damage due to subcapsular pressure, such as one sees in a kidney not treated by opening of its capsule, evacuation of the clots, and stopping of hemorrhage. None of the animals thus treated died, and their convalescence was rapid and satisfactory. No digestion of the renal elements could be distinguished in the damaged areas. Those kidneys which were most severely injured showed marked contraction due to the formation of scar tissue, but in even the most contracted organs the renal elements were undamaged between the scars. On the other hand, failure to open the renal capsule when the kidney has been ruptured results in much fibrosis and some hyalinization. Several of our traumatized dog kidneys thus treated showed a focus of calcification in a pyramid, beneath the mucosal lining, bearing out Randall's recent theory regarding the production of certain kidney stones.

THE USE OF RIBBON GUT IN NEPHROPEXY

A properly performed nephropexy is, we believe, productive of highly beneficial results in carefully selected cases. At the Brady Foundation, during the past 10 years, we have had excellent results in a large number of cases with the ribbon gut method. Chromic ribbon gut, studded at each end with an atraumatic needle, is used.

A series of 12 experimental operations on dogs was performed as a preliminary to the use of this material in humans. The results of the animal experiments were so gratifying that nephropexies were done upon human beings with very slight modification of the technique.

The kidney is exposed through the usual lumbar incision and freed from the surrounding structures by separating adhesions and other clinging tissues.

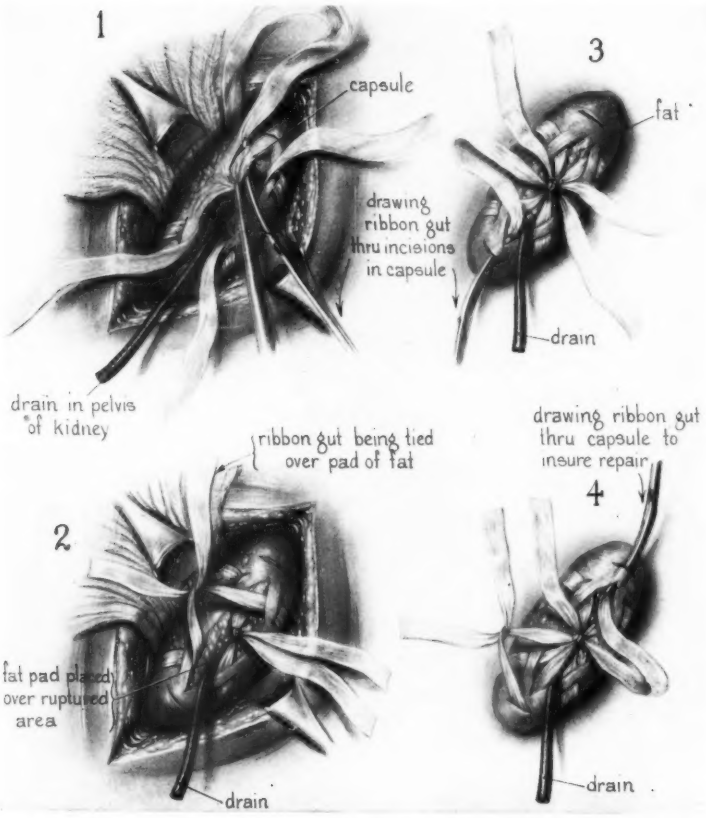

Fig. 7. Repair of ruptured kidney by the use of ribbon gut. 1, The fibrous capsule has been incised, blood clots have been sponged away, and isolated wedges of damaged cortical tissue have been removed. Ribbon gut is being drawn through the fibrous capsule. A drain is passed into the kidney pelvis. 2, 3, 4, A pad of fat is placed over the ruptured area to control bleeding, and the ribbon gut is tied over the fat. (From *Clinical Urology*, by Lowsley and Kirwin (14)).

The fibrous capsule is incised in the midline and stripped back, thus exposing about one sixth of the kidney's surface. Chromic ribbon gut is fixed around both the upper and lower poles of the kidney by passing it through the fibrous capsule. The gut must be tied tightly enough to hold firmly but not so tightly that it compresses the cortical substance. The free ends of the upper and lower strands are then tied together, which helps to hold the two slings firmly in position and forms a basket-like support for the organ. The needle-studded end of the upper-pole strand is inserted through the eleventh intercostal space as far back as possible, drawing the kidney, with its partly denuded cortex, up to the body wall. The kidney must be drawn high enough so that the freed ureter is straight and slightly stretched. The needle is then cut away and the end of the ribbon gut is tied to the end which had previously been tied to the lower strand of gut. The needle-studded end of the lower-pole sling is passed through the quadratus lumborum muscle, the needle cut away, and the end tied to the end which has been tied to the upper strand. After it is made certain that there is no obstruction of the ureter, the wound is closed in the usual manner without drainage.

Eighty-three such operations have been done at the Brady Foundation. There have been no deaths in the series, so it is impossible to tell

anything about the condition of the kidney in the human. The dogs' kidneys examined, however, all showed excellent results, and we have every reason to believe that no damage has been done to the kidneys of the humans thus operated upon. In cases followed up, the pyelograms indicate that the kidneys elevated by this method have all stayed in place, and the patients have been relieved of the symptoms complained of.

LIGATION OF THE RENAL PEDICLE WITH RIBBON GUT IN NEPHRECTOMY FOR TUBERCULOSIS

Occasionally in nephrectomy for tuberculosis the vessels of the kidney are so diseased that an attempt to tie them off with twisted catgut or other ordinary suture material will result in the ligature cutting through the diseased vessels. This is a serious accident as the pedicle is thereby shortened and, in many instances, it becomes necessary to leave clamps on.

After a series of animal experiments in which the kidney pedicles were tied off with ribbon gut, we successfully utilized this method to tie off the pedicle in a number of cases of tuberculosis of the kidney with disease of the vessels in human beings. In no case did the ribbon gut ligature cut through. However, caution is necessary to insure that the knot is tied tightly and not allowed to slip. A sizable rosette of tissue distal to the location of the ligature will aid in keeping the vessels intact.

TOTAL PROSTATECTOMY, WITH RIBBON TECHNIQUE

Ribbon gut has been found to be most useful in performing total prostatectomy by the method described by Lowsley and Kilgore in 1941:

The patient is placed on the operating table in an exaggerated lithotomy position, and a Lowsley curved prostatic tractor is passed into the bladder and its blades are opened. An arcuate incision is made in the perineum, about 1 inch above the mucocutaneous junction of the anus, thus exposing the subcutaneous fat and the central tendon. The latter is isolated from the fatty areolar tissue on either side by blunt dissection. The central tendon is then carefully incised down to the wall of the rectum, which allows the transversus perinei muscles to be retracted anteriorly. The rectum is dissected away from the overlying areolar tissue until the rectourethralis muscle is exposed. This muscle is then incised or retracted laterally, thus allowing the rectum to be dissected away from the base of the prostate. Denonvilliers' fascia is thus exposed from the apex of the prostate to the fascia covering the seminal vesicles. At this point, a transverse incision may be made in the fascia covering the vesicles, which permits greater mobility of the gland later in the procedure.

A transverse incision is then made through the urethra at the apex of the prostate. The curved prostatic tractor is removed and the Lowsley short straight tractor is passed through the prostatic urethra into the bladder and opened. When the tractor is depressed downward, the anterior commissure is exposed. The anterior surface of the prostate is carefully separated from the overlying tissue by blunt dissection, thus bringing into view the anterior margin of the vesical orifice. The lateral surfaces are next separated from the surrounding structures by blunt dissection.

After the prostate has been mobilized down to the wall of the bladder, the anterior commissure is divided in the midline, exposing the vesical orifice and the prostatic urethra. A transverse incision is then made in the prostatic urethra, just distal to the internal sphincter. If the lateral lobe intrusion is so marked that the internal sphincter cannot be visualized, a midline incision may be made through the floor of the prostatic urethra, dividing the posterior and median lobes of the gland. This bisects the entire prostate up to the vesical orifice, and by exerting lateral traction on either half of the gland, good vision is obtained. The prostate may now be freed from the floor of the vesical orifice on both sides under direct vision and with a minimum of trauma to the internal sphincter. As the dissection proceeds downward, a group of vessels will be found entering the gland from each of its lateral aspects, these are tied off and cut, thus preventing the excessive hemorrhage which results when this ligature is not placed on each side.

Bisecting the prostate gland allows good exposure of the seminal vesicles, so that these may be easily removed, or clamped and ligated with the vasa deferentia and the accompanying blood vessels. Bleeding vessels are easily clamped and ligated. A Foley catheter is passed through the urethra and into the bladder.

The cut end of the membranous urethra and the bladder neck are now separated by a considerable space which formerly was occupied by the prostate gland. These two structures are approximated as follows: A suture of untwisted chromic catgut is inserted into the left lateral wall of the urethra, then through the anterior lip of the bladder orifice on the left side, and through the posterior lip of the bladder orifice. It is then carried across the apex of the trigonum vesica and inserted into the posterior lip of the bladder orifice, on the right side, the anterior lip of the bladder orifice, and through the right lateral wall

of the urethra. The bladder is drawn to the urethra, which is fixed with an Allis clamp, and the ribbon gut suture is tied, thus plicating the bladder orifice and the urethral wall—all with one suture. A second ribbon-gut suture is inserted into the left wall of the urethra, carried over the apex of the trigonum, and through the right wall of the urethra, and is then tied, thus reinforcing the first plication suture.

The Foley catheter is fixed in position by injecting the retaining bag, and the bladder is irrigated. One short Penrose drain is placed over the wall of the rectum, and the wound is closed by approximating the levator ani muscles with one or two chromic catgut sutures, and the subcutaneous tissue and skin with interrupted silk or dermal Stewart sutures.

PLICATION OPERATION FOR IMPOTENCE

Because ribbon gut does not cut through delicate tissues, this material was utilized in the development of an operation for the cure of certain types of impotence. This operation consists in compressing the dorsal veins of the penis by a ribbon gut suture and plicating the ischiocavernosus muscle on each side and the bulbocavernosus muscle. A series of animal experiments were first performed, which proved that these muscles are essential to the function of erection; that tightening the ischiocavernosus muscle on each side and the bulbocavernosus, in dogs, produces erections which are under control of the dog's mind. The results in animals were so striking that a series of operations in humans was done. Since the operation was devised, 8 years ago, 166 patients have been operated upon at the Brady Foundation; 90 per cent of these have been cured or greatly improved, and only 10 per cent have failed to show improvement. In all cases the operation was performed as a last resort after all other methods of treatment had been tried, including neurological measures and the administration of hormones.

The operation is done as follows: The patient is placed on the operating table in the exaggerated lithotomy position and a No. 19 F. sound is passed into the urethra. An incision is made over the bulging part of the perineum, extending in the midline from a point about 10 centimeters from the anal margin down toward that structure for about 5 centimeters. A branch is then made laterally on each side to a point just above the attachment of the crus penis, the completed incision resembling an inverted V. The incision is deepened through fat and areolar tissue until the corpus spongiosum, surrounded by the bulbocavernosus, and the crus penis (corpus cavernosum) on each side, surrounded by the ischiocavernosus, are exposed.

Chromic ribbon gut, studded with an atraumatic needle, is inserted into the lateral edge of the bulbocavernosus muscle, pulled across the belly of the muscle, and passed through the other side, with just sufficient strain to plicate the muscle and produce the exact amount of pressure to reinforce any contraction necessary to aid in producing an erection. Two more similar stitches may be required to tighten the whole muscle. A figure-of-eight ribbon-gut suture is inserted into the ischiocavernosus muscle on each side, care being taken not to injure or unduly compress the fairly numerous nerves and blood vessels here. By tightening the suture, a reef is taken in the muscle, thus shortening it by about 1 inch. The wound is closed in layers without drainage.

An incision 4 centimeters long is then made over the suspensory ligament, which is exposed and freed by blunt dissection. A compression suture is placed in the two leaves of the suspensory ligament of the penis, causing a moderate, persistent compression which prevents a too rapid flow of blood out of the organ.

The success of this operation apparently depends upon the use of chromic ribbon gut, which does not tear through the delicate muscles as does ordinary twisted catgut.

PLICATION OPERATION FOR THE RELIEF OF INCONTINENCE OF URINE AND FECES IN THE MALE

At the Brady Foundation, incontinence of urine in males has been cured by plication of the bulbocavernosus muscle, and has been controlled by regular evacuation, in 26 cases in the past 6½ years.

In 1938, the author, in collaboration with Major Robert W. Hunt, now in the Medical Department of the Army Air Corps, did a series of animal experiments in which ribbon gut was used to plicate the rectum and urethra of dogs. These demonstrated that the rectum may be constricted excessively with chromic ribbon gut so that the animal must use great force to evacuate ribbon-like feces. Two dogs in the series had perirectal fistulas, purposely produced, which healed spontaneously. The results of the method were so satisfactory that a small number of humans suffering from incontinence of urine and feces were operated upon, successfully curing a most trying and disabling condition. The principle involved is the production of a narrowing of a relaxed elastic viscus which can be caused to empty by exerting pressure.

Our operation for the cure of incontinence of urine and feces in the male consists of 2 procedures, both of which may be accomplished through one incision in the perineum. An inverted-Y incision is made in the perineum over the bulbocavernosus muscle, the two arms of the Y extending down on each side of the rectum almost to its most dorsal level. The incision is deepened through subcutaneous tissue and Colles' fascia until not only the bulbocavernosus muscle is uncovered but the ventral and lateral walls of the rectum as well. A small sound is passed into the urethra (No. 19 F. in adults, a much smaller one in children). Mattress sutures of chromic ribbon gut are inserted low down on each side of the bulbocavernosus muscle, pulled tightly across the posterior surface, and tied in a square knot. Usually 3 such sutures are needed to plicate the entire muscle, but in children 2 may suffice. The object is to produce an elastic narrowing of the bulbous portion of the urethra so that the patient must use considerable force to empty his bladder.

The tissues are then freed from the anterior and lateral walls of the rectum, the dorsal surface being uninterfered with. A suture of chromic ribbon gut is inserted in the rectal wall on one side and a mattress suture is then taken through the muscularis on the opposite side. This suture is tied tightly, plicating the rectum—a hemostat being inserted in the lumen of the rectum during the tying to determine the desired caliber of the lumen. A second similar plication is made just above the first, and a third if the lumen is not sufficiently constricted by these two.

The first patient operated upon in this manner was a boy of 8 years who had had both ureters transplanted into his sigmoid because of exstrophy of the bladder. Thereafter his partial incontinence of feces became more pronounced until it was practically complete. Plication of the rectal musculature was followed by a rectal fistula which healed rapidly under the influence of alpine light applications. He now has perfect control of his fecal and urinary streams. The second patient was a 10 year old boy with fecal and urinary incontinence due to spina bifida. After the operation he had to be catheterized for several days and was then taught to exert pressure on his bladder, using abdominal muscles and even his hands. His bladder gradually expanded until it held 105 cubic centimeters of urine at time of discharge from hospital. Fecal control was immediate and satisfactory. Control over rectum was obtained by the children being trained to empty this organ at regular intervals, using pressure, until finally they had complete control over evacuations.

OPERATION FOR URINARY INCONTINENCE IN THE FEMALE

In the female, we have also had success in relieving urinary incontinence in numerous instances by two methods of repair in which chromic ribbon gut is used. A dozen female dogs were first operated upon in order to determine the value of ribbon gut for this purpose. The choice of operation depends on the situation which the surgeon encounters. If the urethra is very large and patulous, and the patient is entirely incontinent, the anterior surface of the urethra is plicated with ribbon gut, the viscus being tightened over a No. 10 F. baby catheter, which is left in position for 2 or 3 days. If, on the other hand, the patient merely loses a few drops of urine on coughing or other muscular exertion, encircling the urethra with a piece of ribbon gut and tying it snugly will be all that is necessary to effect a cure. Fibrous tissue replaces the ribbon gut, as shown in the animal experiments.

To date 27 females have been operated upon at the Brady Foundation by these methods. The operative results have been favorable in all but a few cases in which reoperation was necessary.

REPAIR OF HERNIAS WITH RIBBON GUT

In the past 8 years we have used chromic ribbon gut for the repair of hernias which we have encountered in various urological lesions.

The technique employed is as follows: An incision is made from the spine of the pubis upward and outward over the inguinal canal, and deepened through the subcutaneous tissue and conjoined tendon into the inguinal canal. The hernial sac is isolated and opened. A transfixion suture of chromic gut is tied at the neck of the sac, the excess being excised. The tied-off sac is allowed to retract inside the internal inguinal ring. Three or four ribbon-gut sutures are placed under the cord in the transversalis muscle and fixed at the lower border of the shelving edge of Poupart's ligament, the lowest suture being affixed to Gimbernat's ligament at the anterior spine of the pubis. The fascia is then sutured to cover the canal and its contained cord in the usual manner. The wound is closed in layers, silk sutures being used for the skin closure.

In all, we have operated upon 104 inguinal hernias and 6 abdominal hernias by the ribbon-gut method. There have been 2 known recurrences in this series. In one, the patient had been operated upon three previous times, with recurrence in each instance, and the tissues were so scarred and thin that success was precluded by the nature of the field. In the other failure, a

tremendous hernia was present; the patient had worn a truss for 20 years, and this had thinned out the tissues to nothingness.

On the other hand, we have used ribbon gut in 6 cases of recurrent inguinal hernia with success.

We consider ribbon gut to be superior to any other type of repair material for herniorrhaphy in that it is a broader, stronger substance than is ordinarily used; and the resulting repair scar has proved to be more firm and solid than that which results from the use of catgut or kangaroo tendon. Then, too, silk sutures, as well as chromic catgut, which have been largely used for this operation, frequently cut or pull through the tissues, with the resulting recurrence of the hernia.

OTHER USES OF RIBBON GUT IN SURGERY

Attention is called to the fact that many surgeons in all parts of the world are using ribbon gut successfully not only in urological surgery but for the relief of many other surgical lesions.

Mr. Terrence Millin has reported a series of successful operations upon impotents, using the method herein described.

Dr. Daniel Chanis, Jr., of Panama, has reported a new method of suspending the uterus with this material (when the uterus is free and movable and the adnexa intact). In brief, this procedure is as follows: The uterus having been delivered at the abdominal wound, the uterosacral ligaments are snugly brought together over the posterior aspect of the uterocervical segment by 2 or 3 sutures of chromic ribbon gut studded at one end with an atraumatic needle. With a sharp knife, a tunnel is made on the posterior aspect of the fundus uteri. The round ligaments having been drawn through the broad ligaments, one is transfixed by the ribbon gut, which is carried through the tunnel to the opposite round ligament and tied. An extra suture of ribbon gut is placed so as to transfix the round ligaments and the peritoneal covering of the uterus overlying the tunnel.

The repair of rupture of the liver and spleen has been successfully accomplished with this material.

The ligation of a bronchus in lobectomy (pulmonary) has been a useful adjunct to lung surgery.

SUMMARY AND CONCLUSIONS

Ribbon gut, for a number of reasons, has been a great boon to the surgeon. It is an animal membrane, very soft and pliable, which permits the development of fibroblasts between its own fibrils. There is nothing done to this untwisted catgut to prevent this ingrowth of fibroblasts from surrounding structures. It may be made ready for use in the operating room in unlimited amounts at a moment's notice. It is fitted with an atraumatic needle.

In the use of human fascia lata a second operation is necessary; this is time consuming and adds the hazard of another wound.

We have seen no advantage in the use of preserved ox fascia lata, and a number of disadvantages as compared with ribbon gut. The longest ox fascia strips obtainable are only about 12 inches, while ribbon gut is 18 inches in length. In addition to the objection that preserved ox fascia is dead tissue and so will readily slough out is the disadvantage that ox fascia lata cannot be sterilized by heat without destroying its physical integrity. Hence, resort must be had to chemical sterilization, which is dangerous because of its unreliability. On the other hand, ribbon gut possesses the high safety factor of heat sterilization. Moreover, ox fascia lata does not tie very well and a knot made with this material might slip; therefore, it would not be safe for some of the operations on the kidney in which ribbon gut has proved so successful.

Ten years of experience with the use of ribbon gut in renal and prostatic surgery, herniorraphy, and plastic operations for the cure of impotence, incontinence of urine, and incontinence of feces, and reports of the efficacy of this material in suspension of the uterus and other operations have convinced us that ribbon gut is a most important addition to the surgeon's armamentarium. In the various types of operations coming under our personal observation, no material thus far encountered has supplanted or even equalled it.

REFERENCES

1. Chanis, Daniel, Jr. Surg. Gyn. Obst., 1941, 73: 876.
2. Hawes, G. A. Am. J. Surg., 1938, 41: 509.
3. Lowsley, O. S. South. M. J., 1934, 27: 139.
4. Idem. J. Kansas M. Soc., 1935, 36: 397.
5. Idem. J. Missouri M. Ass., 1935, 32: 313.
6. Idem. South. M. J., 1935, 28: 1091.
7. Idem. N. York State J. M., 1936, 36: 591.
8. Idem. J. Urol., Balt., 1936, 36: 400.
9. Ibid., 1940, 43: 275.
10. Lowsley, O. S., and Bishop, C. C. Surg. Gyn. Obst., 1933, 57: 494.
11. Lowsley, O. S., and Conroy, Frank. J. Urol., Balt., 1942, 48: 611.
12. Lowsley, O. S., and Hunt, R. W. J. Urol., Balt., 1939, 41: 252.
13. Lowsley, O. S., and Kilgore, R. N. J. Urol., Balt., 1941, 45: 196.
14. Lowsley, O. S., and Kirwin, T. J. Clinical Urology. Vol. II, pp. 1572–1578. Baltimore: The Williams & Wilkins Co., 1940.
15. Lowsley, O. S., and Menning, J. H. J. Urol., Balt., 1941, 45: 253.
16. Twinem, F. P. J. Urol., Balt., 1940, 44: 596.
17. Yunck, W. P., Jr., and Forsythe, W. E., Jr. J. Urol., Balt., 1941, 46: 396.

THE PATTERN OF UTERINE MOTILITY THROUGHOUT LABOR WITH SPECIAL REFERENCE TO INERTIA

A Study of 105 Patients with the Lóránd Tocograph

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THIS is the second report dealing with uterine motility during labor. The first one concerned the magnitude of the contractions and the effects of advancing labor, parity and dystocia upon it (3).

The present communication considers the pattern of contractions exhibited by patients having normal labors and by those experiencing primary inertia. Both publications are based upon observations on the same group of women.

MATERIALS AND METHODS

Uterine activity was registered with a Lóránd tocograph (1, 4). This is a simply constructed, small mechanical device which records certain characteristics of the uterine contractions through the medium of the abdominal wall.

Observations were supplied by 105 patients delivered in the Hospital of the University of Pennsylvania during 1942 (3). The uterine activity of these women was registered at 1½ to 2 hour intervals from the time they were admitted to the hospital in labor until they were delivered. Tracings of the uterine motility of patients experiencing normal and inert labors appear in Figures 1 to 4. Each figure comprises all of the observations upon a patient. The earliest record appears at the top of each series. All four figures are reproduced on the same scale. The onset of labor was based upon the time that the first pains appeared. In the columns marked "before delivery" the lowermost tracings marked "0," were started within 1 hour of delivery.

The base lines at the ends of each tracing represent the level of the writing point of the tocograph before the instrument was placed upon the patient's abdomen. The tone of the uterus is measured in terms of the elevation of the graph above this base line.

Vertical strokes upon the sides of waves or between them resulted from fetal movement. Vertical lines at the crests of waves, at the end of labor, resulted from bearing down movements produced by voluntary contractions of the abdominal muscles.

From The Gynecean Institute of Gynecologic Research, Department of Obstetrics and Gynecology, University of Pennsylvania.

RESULTS

Pattern of normal labor. Figures 1 and 2 reproduce the contraction patterns of 2 patients who had normal labors. The tracings shown in Figure 1 were secured from a primipara who experienced a 12 hour labor terminating in a spontaneous delivery. Figure 2 illustrates the pattern of a secundipara who had a 16 hour labor also ending in a spontaneous delivery.

The contraction patterns of these two individuals have certain characteristics in common and exhibit certain significant differences. In addition, the patterns of these two patients differ significantly from those of women who experienced primary inertia (Figs. 3 and 4).

The characteristics of the patterns common to the two patients are as follows: (a) The regular recurrence of the contraction waves, and the initiation of this attribute early in labor, (b) the magnitude of the waves, (c) the close resemblance between any one wave and its following trough, with adjacent waves and their respective troughs.

In spite of the number of characteristics of the graphs common to both patients, their contraction patterns differ from each other in a general way.

Pattern of primary inertia. Figures 3 and 4 illustrate the contraction patterns of two individuals who experienced a poor quality of uterine motility from the onset of labor. The tracings in Figure 3 were supplied by a primipara who had a 47 hour labor ending in a breech delivery. Figure 4 reveals the contraction pattern of a primipara who went through a 31 hour labor ending in a mid-forceps delivery.

The patterns of these two individuals have certain characteristics in common and likewise exhibit certain significant differences. Furthermore they differ significantly from the patterns of the patients who had normal labors (Figs. 1 and 2).

The characteristics of the patterns which are common to these two patients are as follows: (a) Contraction waves of average small magnitude, (b) arrhythmicity of occurrence of successive con-

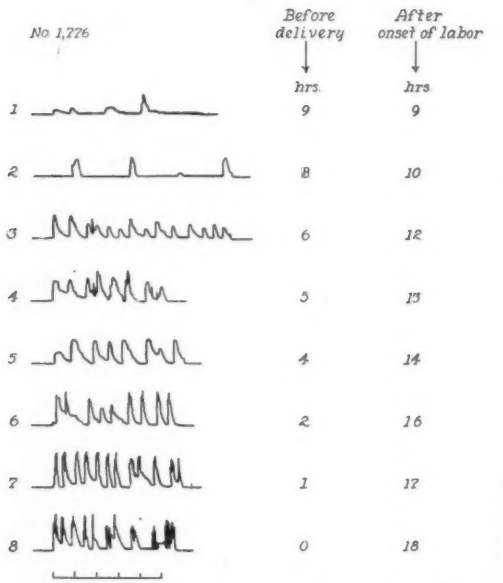

Fig. 1. Tocographic record of a normal 18 hour labor in a primipara. Tracing 1: cervix dilated 4 centimeters. Tracing 7: cervix dilated completely. Time intervals 3 minutes. Note: (a) rhythmicity of waves, (b) magnitude of waves which increases progressively, (c) similarity in size and shape of successive waves. Compare with same characteristics in tracings of primary inertia, Figures 3 and 4.

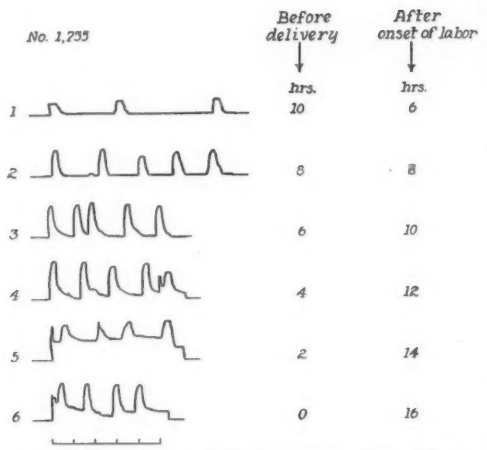

Fig. 2. Tocographic record of a normal 16 hour labor in a multipara. Tracing 1: cervix dilated 1 centimeter. Tracing 6: cervix dilated completely. Time intervals 3 minutes. Note: (a) rhythmicity of waves, (b) magnitude of waves, (c) similarity in size and shape of successive waves. Compare with same characteristics in tracings of primary inertia, Figures 3 and 4.

tractions, (c) waves which fail to resemble each other very closely in shape and magnitude. The outstanding difference between the patterns of these two patients is the disparity in the degrees of their uterine tonus. Figure 3 shows a low uterine tone (hypotonic inertia) with the wave troughs on the level of the base lines; Figure 4 reveals a high uterine tone (hypertonic inertia).

The patterns of the patients experiencing primary inertia differed significantly from the patterns of the patients having normal labor in respect to items, a, b, and c.

EVALUATION OF STUDY

To distinguish more readily the difference in the contraction patterns associated with normal and inert labors, the tocographic criteria of a normal labor might be restated in the following terms: Normal labor is characterized by a pattern in which, in one's mind's eye, it is possible to superimpose any one contraction wave and its following trough, upon either of its adjacent waves and their respective troughs. The more nearly this ideal can be approached the better is the quality of the uterine motility. Early in labor this rule holds true even though the magnitude of the waves may be small, although the earlier that large waves are established the more rapid will be the progress of labor. Good uterine motility during labor can be predicted, even before the onset of labor, if a pattern of contraction measuring up to the above criteria is established at that time.

Unpublished observations made with the tocograph upon many patients not included in this report, show that each individual possesses a distinctive contraction pattern during pregnancy which in a modified form is carried over into labor.

The accompanying illustrations indicate the extent to which the pattern of contractions present early in labor is maintained throughout the remainder of labor. This persistence of the pattern makes it possible for us to secure, early in the labor, a fairly good idea of what the rest of the labor will be like. And for this purpose ordinarily it is necessary to secure only two tracings, taken about an hour apart.

Such observations make it possible for us to detect the existence of uterine contractions of poor quality relatively early. With this knowledge we are placed in a position to treat primary inertia earlier and therefore better.

According to Lóránd, primary inertia is characterized primarily by the feebleness of the uter-

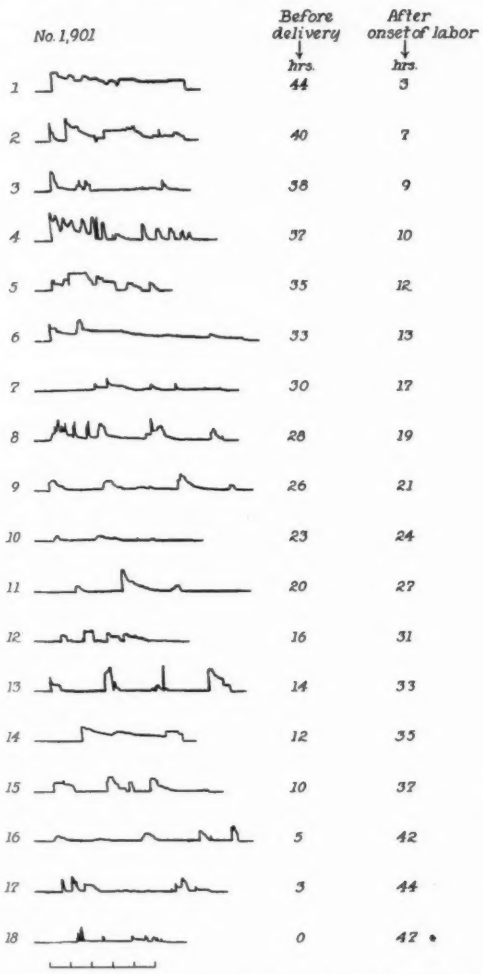

Fig. 3. Tocographic record of a 47 hour labor complicated by hypotonic primary inertia, in a primipara. Tracing 1: cervix dilated 6 centimeters. Tracing 7: cervix dilated completely. Time intervals 3 minutes. Note: (a) absence of good rhythmicity of waves, (b) small size of waves, (c) dissimilarity in size and shape of successive waves, (d) no elevation of waves above base line. Compare wave characteristics with those in tracings of normal labor, Figures 1 and 2.

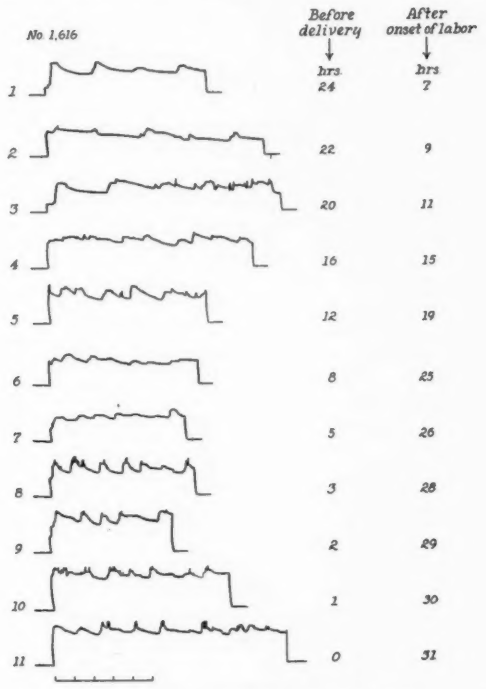

Fig. 4. Tocographic record of a labor of 31 hours complicated by hypertonic primary inertia in a primipara. Tracing 1: cervix dilated 6 centimeters. Tracing 7: cervix dilated completely. Time intervals 3 minutes. Note: (a) absence of good rhythmicity of waves, (b) small size of waves, (c) dissimilarity in size and shape of succeeding waves, (d) high uterine tone, indicated by elevation of main part of each tracing above base line at ends of tracing. Compare wave characteristics with those of tracings of normal labor, Figures 1 and 2.

ine contractions. To this we would add the arrhythmicity of occurrence of the contractions and their failure to resemble each other.

A consideration of primary inertia from the standpoint of its tocographic detection should not be passed over without drawing attention to Lóránd's important contribution to this subject. Lóránd recognizes three degrees or types of primary inertia: (1) normotonic, (2) hypotonic, (3) hypertonic (Fig. 5). In each instance the uterine contractions are feeble but also in each case the tonus of the uterus is different.

The treatment of primary inertia continues to be a matter of discussion among obstetricians, and this applies especially to the use of oxytocic drugs. Some physicians use such drugs and others do not. Lóránd considers that the decision to employ an oxytocic substance in the treatment of primary inertia should depend upon the type of inertia which is present. If the uterine tone is normal or low, oxytocic drugs in very small dosage—1 minim or less—can be employed safely, but if the uterus is hypertonic the use of any oxytocic drug is

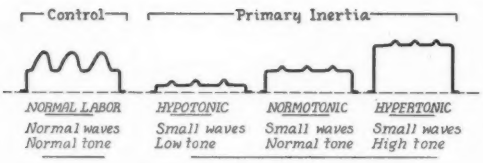

Fig. 5. Lóránd's classification of primary inertias. Diagrammatic representation of tocographic picture of: (a) normal labor, (b) hypotonic, normotonic and hypertonic primary inertia. Note: (a) small size of waves in all types of primary inertia, (b) different degrees of uterine tone associated with the small waves of primary inertia.

contraindicated. In such cases it is far safer to rupture the membranes if this has not occurred already. The employment of an oxytocic drug when the uterus is hypertonic is very likely to increase further the tetanic state and thus may lead to serious consequences. In view of our knowledge of the uterine motility which occurs during labor, gained from tocographic recordings, we are fully in accord with Lóránd's statements regarding the use of oxytocic drugs. We might add that the successful treatment of primary inertia is greatly aided by the securing of repeated tocographic records of the uterine activity. They assist in determining the type of the inertia, and in recording both the character and degree of the uterine reaction to any oxytocic drugs which may be employed. Under tocographic control it becomes safe to use small doses of oxytocic drugs in the treatment of primary inertia.

SUMMARY AND CONCLUSIONS

1. The uterine contractions of 105 women in labor were recorded graphically with a Lóránd tocograph. Observations were made at 1½ to 2 hour intervals throughout the greater part of labor.

2. Each individual experienced a contraction pattern which was peculiar to herself.

3. Normal labor was characterized by: (a) contractions of appropriate magnitude, (b) a relatively high degree of rhythmicity of occurrence of successive contractions, (c) contractions which resembled each other fairly closely in magnitude and in general character.

4. Primary inertia was characterized by: (a) contractions of small magnitude, (b) considerable arrhythmicity of occurrence of successive contractions, (c) contractions which failed to resemble each other in magnitude and general character.

5. The classification of inertias into normotonic, hypotonic, and hypertonic as described by Lóránd is outlined and confirmed.

6. From our observations we conclude that the Lóránd tocograph is a useful instrument for detecting the presence of primary inertia, and distinguishing the type.

REFERENCES

1. Lóránd, S. Mschr. Geburtsh. Gyn., 1936, 103: 137–145.
2. Idem. Zbl. Gyn., 1937, 61: 1285–1291.
3. Murphy, D. P. Surg. Gyn. Obst., 1943, 76: 60–63.
4. Idem. Surg. Gyn. Obst., 1941, 73: 681–685.

EDITORIALS

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MASSIVE GASTRIC HEMORRHAGE

ACUTE, chronic, chronic perforating, and bleeding peptic ulcers are more prevalent today than at any previous time. Under the stress of war the tempo of the layman, the industrial worker, and the men in the services has been stepped up beyond all past experience. In many communities the normal population of peace times has been increased one hundred per cent or more, and the daily life of all these individuals is characterized by stress, strain, and anxiety. With the increasing prevalence of acute peptic ulcers, and particularly the reactivation of chronic ulcers, hemorrhage from stomach and duodenal ulcers is becoming a more frequent problem for the internist and the surgeon, so it seems fitting that it should be reconsidered and emphasized at this time.

The place of surgery in gastric hemorrhage is definitely debatable. Whether surgery should or should not be done in a given case is yet unsettled by any criteria which may be laid down for routine following. Mortality statistics of massive gastric hemorrhage (with or without operation) are not widely confirmed by the medical profession, nor based on facts that are sufficiently substantial for acceptance at this time. Prior to fifteen years ago, almost everyone followed the conservative methods of treatment for gastric hemorrhage, and the confusion today is due to propaganda set forth by Finsterer and Meulengracht which, when compared, is diametrically opposed.

About 1927, Finsterer reported a large series of cases in which he advocated immediate surgery and stated that operation of a radical nature—meaning resection—if done within forty-eight hours, resulted in a mortality rate of only 5 per cent, whereas operation delayed for seven days or more resulted in a mortality rate of 33⅓ per cent.

In 1935, Meulengracht[1] reported a series of 251 cases with a mortality rate of 1 per cent in which the treatment consisted of immediate feedings of food, even gross food, such as meats, potatoes, stewed fruits, cheese, and fresh bread. He compared this with a series of control cases which had been treated conservatively by the Sippy type diet, in which the mortality rate was 7.9 per cent. It must be remembered in considering this subject, that the patient with the average mild or repeated mild gastric hemorrhage may not require operation, while patients with severe symptoms do demand hospitalization and probably surgery. It must also be remembered that, in the case of surgeons in general, the mortality rate following operations in severe cases will undoubtedly be 10 per cent or more. The old accepted teaching has been

[1]Lancet, 1935, 2:1220.

that with one hemorrhage, conservative treatment should be advocated, with two hemorrhages operative interference must be considered, and with three hemorrhages operation should always be done. This is probably true as to the third hemorrhage in a given case, but the rule cannot be applied generally.

An example of this contention can be illustrated by the following case of a patient recently seen, a man, forty years old, who had had ulcer symptoms over a period of years, though the pain had never been severe. He had never consulted a physician. Without warning he had a massive hemorrhage. It is reasonable to argue that this type of case does not demand immediate operation for three reasons: (1) The patient had never had any intelligent medical care; (2) we know that this type of ulcer is technically difficult to deal with by operation in an emergency; and (3), the patient may never bleed again. On the other hand a patient who has had severe pain which has proved intractable to medical care and is associated with massive hemorrhage should be subjected to surgical intervention without delay. Such symptoms usually mean a chronic ulcer on posterior wall penetrating into pancreas and, therefore, most unlikely to undergo spontaneous arrest of hemorrhage.

It is thus seen that two types of hemorrhage demand surgery: (1) that in which massive hemorrhage has recurred; (2) that in which a massive hemorrhage is associated with a chronic ulcer penetrating into the pancreas.

In operative procedures in these cases, due consideration should also be given to the question as to just how much protection surgery will afford against future hemorrhage. It is my opinion that protection afforded against future hemorrhage by surgery is directly proportionate to the amount of radical surgery done. Conservative operations—plastics, simple excision, or gastroenterostomy—afford protection in 50 per cent, whereas radical resection affords protection in 85 per cent of cases.

The surgeon should further be familiar with the probability of spontaneous arrest of hemorrhage in ulcer cases. Statistics now well establish the fact that in hemorrhage cases patients under fifty years of age are usually afforded spontaneous arrest of bleeding and protection in all but 4½ per cent, and all patients over fifty with massive hemorrhage show spontaneous arrest in only 33 per cent of cases.

It would be interesting to discuss the instance of bleeding in a large series of cases in other conditions such as esophageal varix, chronic gastritis, and pedunculated tumors, particularly the leiomyosarcomas. Such statistics show that the instance of bleeding in duodenal and gastric ulcer is approximately 10 per cent, in gastric cancer 8 per cent, in gastrojejunal ulcer 20 per cent, in esophageal varix 17 per cent, in solid tumor of the stomach 75 per cent, and in chronic gastritis 9 per cent.

The advantages of the Levin tube in the immediate treatment of gastric hemorrhage should be emphasized. Its use is advisable for four reasons: (1) It eliminates gastric secretions and saliva which materially interfere with the formation of a strong occlusive thrombus; (2) it keeps the stomach empty and contracted which, as in urinary bladder, is the most favorable state for thrombus formation; (3) it indicates to us any episodes of fresh bleeding early, before there is a marked fall in blood pressure or development of nausea; (4) it eliminates vomiting which, as we all know, contributes to additional hemorrhage by the dislodgment of occlusive clots. Finally, in a given case of massive hemorrhage it is impossible to tell whether the patient will live or die. The mortality rate of conservative is lower than that of operative treatment, so it would seem best to adopt medical management first.

ROBERT L. PAYNE.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE second revision by Dr. Christian of Osler's universally standard textbook[1] of medicine is the 14th edition of this famous reference work, revised and published in 1942. This edition marks the 50th anniversary of the original Osler edition of 1892. Intervening revisions from Osler's 9th to Christian's 13th were edited by Dr. Thomas McCrae, previously assisting Osler.

As noted by Christian, Osler's *Medicine* has always epitomized the practice of medicine as modified by the guiding hand of an editor who gathered and interpreted medical wisdom in the light of personal hospital, office, and teaching experience over a long period of years. Thus the text remains the portraiture of disease largely as seen by three authors against the background of periodic advances in medical knowledge made by men the world over. Thus a continuity in thought and a balance in description has obtained, obviating the fault inherent in books of multiple authorship.

The organization remains the same as that originally designed by Osler, with minor alterations. No new major sections have been added, nor important deletions or changes in order of subject matter. Yet, a comparison of this edition with the 8th, the next to the last edited by Osler published in 1919, reveals a 25 per cent increase in size. This is indicative of the thoroughness with which successive editions have been revised. Study of the organization of sections further shows that time and change in knowledge have not been permitted to introduce any hint of obsoleteness. Careful manipulation by its editors has reclassified diseases as their nature and case have been more clearly revealed; obsolete terms have been weeded out; simplification of knowledge has been recognized by simplification of classification.

Adequate description of detail would be impossible because of size. A few examples will illustrate the insight with which revision has kept this old text up to date. The use of sulfadiazine in the treatment of bacterial pneumonia is included in detail. Yet an accurate description of virus pneumonia points out that sulfonamides appear to be of no benefit. The section on diabetes mellitus contains a concise review of modern physiological advances and their possible significance in terms of etiology. Treatment with with protamine zinc insulin is described in detail and the practically important fact is pointed out that it must not be mixed with ordinary insulin but injected separately. The excellent section on diseases of the nervous system has been retained and amplified.

This dignified reference work in all phases of internal medicine, written and edited by scholarly practitioners with wisdom and experience in a uniformly simple, complete and concise style, may well rank as the leading authority in internal medicine in the world today. Every student and internist should know it well.

ARTHUR R. COLWELL.

THE 7th edition of *Diseases of Women*,[2] a textbook that has been used for many years in England, has recently been published. The list of authors assures one that the opinions are well founded and well tried. It is highly praiseworthy that, in the midst of war and with many of the authors in active military service, they still found time to bring their textbook down to date and give modern teaching to students.

This is a small book of 435 pages, but it covers the whole field of gynecology and also includes a concise section on disorders of micturition. My chief criticism is based on the obvious limitations imposed by the lack of space, which prevents adequate treatment of some of the subjects. Hence, there is no bibliography whatever in the book, and no reference to the historical features or sources of our knowledge. Because of lack of space, some subjects are compressed almost into outline form. Menstruation includes only 2 pages, vaginal discharges are considered in 4 pages, and pruritus is likewise hardly more than mentioned. These are common complaints and their treatment is of greater practical interest to the average doctor or student than the details of surgical anatomy and embryology.

Perhaps the lack of space is responsible for the rather matter-of-fact manner in which endocrine therapy is dismissed. In some parts, it is well presented; in others, it is dismissed by didactic statement. In general, we are not as sure of ourselves in endocrine therapy as these authors seem to be, especially in the treatment of such things as functional bleeding.

On the other hand, some subjects are treated very completely—the chapters on tubal pregnancy, fibromyoma, infections, and other major subjects being good. The method of discussing adolescence, the menopause, and amenorrhea is very clear and sensi-

[1] THE PRINCIPLES AND PRACTICE OF MEDICINE. Originally written by Sir William Osler, Bart., M.D., F.R.C.P., F.R.S. Designed for the use of Practitioners and Students of Medicine. By Henry A. Christian, A.M., M.D., LL.D., Hon. Sc.D., Hon. F.R.C.P. (Can.), F.A.C.P. 14th ed. (semicentennial, 1892–1942). New York and London: D. Appleton-Century Company, Inc., 1942.

[2] DISEASES OF WOMEN. By Ten Teachers under the direction of Clifford White, M.D., B.S. (Lond.), F.R.C.P. (Lond.), F.R.C.S. (Eng.), F.R.C.O.G. Edited by Sir Comyns Berkeley, Clifford White, and Frank Cook. 7th ed. Baltimore: The Williams & Wilkins Co., 1942.

ble. The chapter on urinary diseases is short and to the point.

In general, this book might be very useful for the student who must get a superficial knowledge of the subject, but who does not expect to practice gynecology. It seems too superficial for the practicing physician, surgeon, or teacher.

Nevertheless, as a compendium or condensed collection of the views of these eminent authors, the book is valuable to us all as an expression of sound experience. It is a safe basis for guiding students and physicians to further study. In view of the experiences through which England has been passing in the past year or two, we can only commend the scientific zeal which urged the completion of this revision and the maintenance of up-to-date and efficient teaching in British medical schools.

LAWRENCE R. WHARTON.

A WELL conceived, carefully outlined, concise and lucid presentation of a very important and timely subject is made by an authority in *Shock*[1] by Virgil H. Moon. It is a very practical book. It not only deals with the essential physiological and pathological features and theories of shock, but it also provides chapters on the diagnosis, prevention, and treatment of shock. The subject matter is so concisely presented and well indexed and outlined, that the busy physician will have time to read and refer to those subjects concerning which he needs ready information. The book is highly recommended to everyone whose practice presents conditions in which shock may occur.

A. C. IVY.

WRITTEN by a medical authority on legal medicine *The Pathology of Trauma*[2] is designed to cover the pathological anatomy and pathological histology of traumatic lesions. It does not delve into the clinical aspects of this subject.

The book is concise, clearly written, and stripped of excess words. It is so arranged that each chapter deals with the effect of various forms of trauma on one particular organ or system. Especially to be commended are the portions dealing with intracranial hemorrhage as well as the effect of trauma on the heart and kidney. The illustrations are not numerous but well chosen and reproduced. There is an excellent bibliography at the end of each chapter.

This book should be of value to coroners, medical examiners, students, and teachers of pathology. It does not aim to give much assistance toward solving questions of diagnosis or treatment.

G. R. DOCHAT.

THE little book of 154 pages entitled *Gynecologic Surgery*[3] by Goldberger makes no attempt at being a textbook and contains no clinical discussion of the field of gynecologic surgery. Conditions requiring operative therapy in the field of gynecology are named and the procedures used for their correction are given. The indications for operation and the various steps of the procedures commonly used are named. These are given in outline form without discussion except, occasionally, such statements as "rarely used." All of the methods of surgical therapy are included, the steps being set forth briefly and clearly. The book will be useful for students or for men who, after some years in general work are trying to acquire a familiarity with gynecologic surgery. A number of blank pages are provided for the making of notes. A statement on the cover indicates that the book is one of a series of short outlines being published by the same firm.

W. C. DANFORTH.

THE author of *Cancer of the Uterus*[4] is the first director of the Marie Curie Hospital, London. The book is a small one of 180 pages and deals especially with the management of cancer of the cervix uteri and the corpus of the uterus. Short chapters are devoted to the consideration of the pathology of uterine cancer and its lymphatic extension. The author stresses the importance of early diagnosis as the most efficient means of lowering the cancer death rate. She expresses an optimistic opinion when she says that, were all cases seen in their early stages, 60 to 70 per cent of cervical cancers and 80 to 90 per cent of corpus cancers might be cured. With sufficiently early diagnosis this would probably be true. Treatment is dealt with in detail. The descriptions are clear and when illustrations are needed they are supplied. The diagrams indicating the extent to which the effect of radiation may be expected to go are instructive. The dosage, both of radium and x-ray, at the Curie Clinic seem a little large to workers in some of the clinics in this country but she explains that treatment is extended over some time.

Technique is fully described, the methods of intracavitary irradiation being indicated, with some discussion of methods employed in clinics other than her own. No large series of patients can be irradiated for malignant disease without some untoward sequelae. Complications and injuries are frankly discussed.

Cancer of the cervical stump is dealt with in a separate chapter. The author states that a more extended use of total hysterectomy would decrease the number of cancers of the retained stump and quite properly states that the wider employment of the more extended operation should depend upon whether its increased mortality over that of the subtotal operation is greater than the incidence of cancer in the stump. The rather extensive study published in 1940 by Behney of Philadelphia on this subject is not mentioned.

In addition to the discussion of cancer, the author includes a chapter on cancer of the vagina and vulva.

[1]SHOCK; ITS DYNAMICS, OCCURRENCE AND MANAGEMENT. By Virgil H. Moon, A.B., M.Sc., M.D. Philadelphia: Lea & Febiger, 1942.

[2]THE PATHOLOGY OF TRAUMA. By Allan Richards Moritz, M.D. Philadelphia: Lea & Febiger, 1942.

[3]GYNECOLOGIC SURGERY. By Morris A. Goldberger, M.D., F.A.C.S. London, New York, and Toronto: Oxford University Press, 1942.

[4]CANCER OF THE UTERUS. By Elizabeth Hurdon, C.B.E., M.D. London: Oxford University Press, 1942.

The views expressed here are those which are well accepted although in most American clinics irradiation is not believed to have great value. The last chapter discusses nonmalignant bleeding. This is well presented although not all gynecologists would feel that they should wait until the hemoglobin is as low as 20 per cent before interfering. We agree that radium should be withheld from the younger patients unless strongly indicated but curettage might well be used before extreme anemia develops.

The book presents an excellent study of the work of the Curie Clinic together with a concise and very sane discussion of the subject of uterine cancer. Workers in other clinics will find it useful.

W. C. DANFORTH.

IT is refreshing and delightful to encounter "amidst the tyranny of medical literature" such a fine book as *The Hemorrhagic Diseases and the Physiology of Hemostasis*[1] by Armand J. Quick; one might justly state that this work is a "classic."

The history of the development of our knowledge of the hemorrhagic diseases and of the physiology of hemostasis has been presented in a well ordered, clear, and concise manner. In spite of the many important contributions to the subject by the author, one is particularly impressed with his modest and painstaking scientific presentation.

Proper credit is given to each investigator and a very comprehensive bibliography is appended to each chapter. The first portion of the book deals with the physiology of hemostasis, and the latter portion is devoted to a correlation of the results of these studies with the clinical manifestations and therapeutic management of the hemorrhagic diseases.

The format is excellent; the type is large and printed on good paper. There are many excellent tables and charts.

The reviewer heartily recommends this book to all investigators, students, and practitioners of medicine.

GEORGE H. COLEMAN.

FULFILLING the need "for a manual to present to the medical and dental professions a concise text that would deal with the early first-aid treatment of face and jaw injuries, at the site of injury," the small book, *Synopsis of Traumatic Injuries of the Face and Jaws*, by Douglas B. Parker[2], entitles the author to feel that he has accomplished his purpose.

Disclaiming the intent of offering a textbook on the subject of oral or plastic surgery, the author has drawn upon his own years of experience and that of many others, well known and respected in this field, in such an admirable way that the book could well be used as a text. Especially is this true in the training of dentists to greater familiarity with the problems of care and treatment of maxillofacial injuries.

The general surgeon who reads this book will realize how valuable will be the assistance of a dentist trained according to the precepts set forth in it, and will himself be more aware of this branch of surgery. There are no unproved theories, no extraneous material, nothing but sound information and teaching, concisely presented.

Of particular value are the chapters on first aid, shock, burns of the face, and the newer methods of treating jaw fractures. Surgical reconstruction and surgical prosthesis are subjects of wide interest and the chapters devoted to their consideration are well done. The book is an achievement, and it is amazing that so much of real value is found in this pocket sized book of 326 pages.

FREDERICK W. MERRIFIELD.

A CRITICAL selection of the worth while articles of the year on orthopedic and traumatic surgery is presented in *The 1942 Year Book of Industrial and Orthopedic Surgery*[3] by an editor exceptionally qualified for the task. The whole value of such a work depends on the experience and wisdom of its editor for he must cull the essence from the literature and assemble it in a series of reviews interpolated with occasional editorial notations. As a matter of general policy, only reviews of proved therapeutic value appear.

Particularly noteworthy is a series on fractures and their treatment. Those articles foreshadow marked changes in the older standard methods of treatment, with a marked shift toward various methods of internal fixation and they begin to show the influence of war surgery. There are several articles on the confusing, painful affections of the shoulder, and in the same section are found both medical and surgical care of the related scalenus anticus syndrome. One finds very little about the Kenny treatment of infantile paralysis but, on the other hand, revolutionary changes in the care of acute osteomyelitis. The editor believes that the subject matter of orthopedic and traumatic surgery should be grouped and this selection of reviews would certainly be of interest to both.

At the end of the volume about 50 pages are devoted, entirely, to the problems of industrial medicine. The handy size, good illustrations, over 300 in this one, and generally excellent format of the year book is too well known to require comment.

ROBERT C. LONERGAN.

A VOLUME of about 900 pages, *A Textbook of Gynaecological Surgery*,[4] deals entirely with the technique of pelvic surgery. Diagnosis and path-

[1] THE HEMORRHAGIC DISEASES AND THE PHYSIOLOGY OF HEMOSTASIS. By Armand J. Quick, Ph.D., M.D. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1942.

[2] SYNOPSIS OF TRAUMATIC INJURIES OF THE FACE AND JAWS. By Douglas B. Parker, M.D., D.D.S. St. Louis, Mo.: The C. V. Mosby Co., 1942.

[3] THE 1942 YEAR BOOK OF INDUSTRIAL AND ORTHOPEDIC SURGERY Edited by Charles F. Painter, M.D. Chicago: The Year Book Publishers Inc., 1942.

[4] A TEXTBOOK OF GYNAECOLOGICAL SURGERY. By Sir Comyns Berkeley, M.A., M.C. Cantab., F.R.C.P. Lond., F.R.C.S. Eng., M.M.S.A. (Hon.), F.R.C.O.G., and Victor Bonney, M.S., M.D., B.Sc. Lond., F.R.C.S. Eng., F.R.A.C.S., M.R.C.P. Lond. 4th enl. rev. ed. London, New York, Toronto, and Melbourne: Cassell & Co., 1942.

ology are not touched upon. Some of the chapters have been rewritten and such new material has been added as the advances in gynecological surgery have demanded. Forty-four new illustrations have been added. The illustrations, for the most part, are line drawings and indicate well the steps in the performance of various procedures although they lack something of the artistic appearance characteristic of wash drawings. A number of excellent colored plates are included. The authors are both men of great experience and of reputation not bounded by the limits of their own country. The book gives an excellent idea of operative gynecology as practiced by the best of our British confrères. Although, as the authors state, their intent is to describe operative procedures in such a manner that those of lesser experience may understand them, the book is well worth the attention of all who are interested in the field of gynecology.

The name of one of the authors has long been associated with the extended operation for cancer of the cervix. The chapter on this subject is of particular interest. The technique is clearly described and the facts as to choice of cases and results are given with entire frankness.

A chapter is devoted to intestinal operative procedures. The pelvic surgeon should by all means be able to attend to operative injuries of the bowel, but the inclusion of a description of excision of the rectum seems somewhat beyond the bounds of gynecology.

The chapter on postoperative care is a useful one and one may commend it, although in most clinics in this country infusion is not given by cutting down upon the vein and inserting a cannula but by the simple use of a needle. Postoperative complications are adequately discussed.

A note of conservatism seems to pervade the book and this does not lessen its value, particularly to the younger surgeon. The book deserves commendation and should be among those to which one may refer who seeks information concerning the surgical part of the specialty of gynecology. The epilogue, which has been added to this edition, is commended to those whose reputations are in the making. This revision should considerably extend the already long and useful life which this work has enjoyed.

W. C. Danforth.

IN A small, convenient-sized pocket manual of 96 pages Raven, in *The Treatment of Shock*,[1] summarizes briefly the present day conception of some of the variables which constitute the shock syndrome and the advances in treatment. In the introduction, the author calls for a uniform system of documentation not only for following shock cases but also for comparison and analyses. Raven is hopeful that the mystery of shock may be soon solved by intensive study. This hope is too optimistic, as the complex question of shock will ever challenge inquisitive workers until the millennium.

The terms "primary" and "secondary" are retained but Blalock's classification is urged as a basis of a clearer differentiation. The cause of primary shock is attributed to the activity of the nervous system. If the blood pressure does not return within an hour, some degree of seondary shock is present and transfusion is indicated. Harmful psychical influences are to be combatted and the patient reassured. Vasoconstrictor drugs are indicated if an active vasodilatory substance is known to be present. The treatment and resuscitation methods should be instituted early so as to minimize the sequelae of secondary shock. The author then cites the clinical picture of secondary shock and adds data on the crush syndrome in which signs of renal failure, such as decrease in urinary output, the presence of albumin and blood casts, and increase in blood urea and blood potassium together with a rise in blood phosphorus and a fall in plasma chlorides manifest themselves. A photograph depicting the crush syndrome is used as a frontispiece and a chart illustrates the use of plasma and eucortone (adrenal cortical extract). Postmortem findings are those of swelling, extensive muscle necrosis, and degeneration of renal tubules. In the chapter on "The Pathology of Secondary Shock" the author wisely states that one theory can not be expected to explain the complicated interplay of the agencies at work. The usual theories of causation of shock are reviewed, such as fluid loss, toxin, etc. In discussing blood changes, Raven fails to make the jump that as a result of decreased blood volume, changes result in the blood due to the ingress of cell water which in themselves are wholly abnormal and impair normal physiological function. Barcroft's classification of anoxia is given and due stress is laid on Haldane's teaching: "Anoxia not only stops the machine but wrecks the machinery." Krogh's work that capillary stasis from oxygen deficiency is irreversible after 15 minutes is wisely recalled. The relation of the adrenal cortex to shock is reviewed but not clarified. The fact that it controls several of the variables in shock needs emphasis. One reason why this form of therapy has not advanced is due to the failure of employing the recognized laboratory tests which measure fluid and salt concentrations. Due emphasis is given to blood transfusions in the restoration of blood volume and the employment of plasma or serum in those instances when properly matched blood is not available. Chapter VII is a concise presentation on the "Methods of Oxygen Administration." The methods of blood and plasma transfusions are well illustrated portraying the types of apparatus used in the Army and in the Emergency Medical Service. Why warming the blood before administration is necessary is not stated. A convenient method of preparing liquid plasma is illustrated. The preparation of dried plasma by the method of Edwards, Kay, and Davie is depicted. This cannot compare with the preparation of plasma from the frozen state. The chapter on

[1] The Treatment of Shock. By R. W. Raven, F.R.C.S. (Major, R.A.M.C.). Edited by the Rt. Hon. Lord Horder, G.C.V.O. London: Humphrey Milford (Oxford University Press), 1942.

"Anesthesia" is brief and to the point in that chloroform has made way for cyclopropane and pentothal induction. The warning against spinal anesthesia and Macintosh's insistence of maintaining a clear airway throughout the whole period of unconsciousness together with adequate oxygenation are stated.

The deferring of surgical intervention until the systolic blood pressure stabilizes around 100 is mentioned. This is not wholly correct for such operations should not be deferred if those factors which are causing shock are operating, such as a bleeding artery or a swelling limb resulting from inadequate immobilization of fractures. Under such conditions, the operation and the resuscitation should go on together. The teachings of Larry and the experiences of the last war are clear that the longer the operation is deferred the higher the mortality.

There are 79 references and the volume is well indexed.

JOHN SCUDDER.

THE text of *The Antigonadotropic Factor; with Consideration of the Antihormone Problem*[1] by Zondek and Sulman, while dealing primarily with the antigonadotropic factor, embodies an extensive and complete résumé of the voluminous experimental data obtained in previous studies of the antihormone problem. Each phase has received separate and detailed consideration by comparison of the original data and theories with subsequent evidence much of which has been contributed by Zondek and Sulman themselves.

While the evidence presented is essentially experimental, clinical studies have been included in an effort to establish the validity of the theory and to ascertain its clinical significance.

The conclusions presented by the authors, which are of greatest significance to the clinician, suggest the following: (1) definite antihormone factors do exist; (2) these factors are not hormones or antibodies but they must be classified as immune bodies of a character hitherto unknown in serology; (3) only protein-containing hormones, especially of the pituitary and of the adrenals, have been known to evoke the formation of "antihormones"; (4) hormones of the steroid group (i.e. testosterone, androsterone, estrone, progesterone, adrenosterone, corticosterone), do not produce antihormone factors and the possibility need not be considered in protracted therapy with these substances; (5) the production of antihormone factors need not be considered in protracted therapy with insulin, adrenalin, thyroid hormone, pitressin, or pitocin; (6) a certain degree of refractoriness has been obtained by the administration of adrenal cortex, of the hypophyseal gonadotropic, and thyrotropic factors, and of the parathyroid hormone; (7) the production of antigonadotropic hormone factor must be considered in protracted therapy. Clinically the administration of actual pituitary gonadotropic substance and of pregnant mares' serum is most likely to produce these factors while preparations from pregnancy urine (prolan, i.e. chorionic gonadotropic substance), menopause urine, or normal male urine have not been found to produce antigonadotropic factors. The authors suggest as a precaution that pituitary gonadotropic or pregnant mares' serum preparations should not be administered over a period of time exceeding 2 to 3 months and that if continued therapy is indicated a prolan preparation be substituted. Finally, the authors emphasize the warning *that protracted treatment with gonadotropic hormone regardless of its source may ultimately induce physiological as well as morphological injury to the hypophysis.*

PHILIP F. SCHNEIDER.

THERE are two schools of thought on the most effective type of book on baby care to put into the hands of a mother. Some physicians believe that the most useful book is that which presents a few general principles of physical and mental health, in such a way that they may be understood and accepted. They feel that too much concentrated information tends to confuse and frighten the mother, so that like the proverbial medical student she sees things that are not there.

Others believe that a good nursery guide should contain full instructions for every crisis, major or minor, that a mother might meet. Dr. Kenyon's well known book[2], now in its third edition, is an excellent example of the latter.

Beginning with a chapter on prenatal care of mother and child, it gives up-to-date and specific instructions on the health, care, feeding, and training of the baby during the first 3 years of life. The material is advantageously presented on a month-to-month basis, so that the mother may easily find in one place the particular advice about her baby that is suitable for its age.

In addition to questions of nursery equipment, clothing, hygiene, infant feeding, diets, exercise and habit training, the book discusses such subjects as tuberculosis, communicable diseases, the development of chemotherapy, the treatment of emergencies and first aid. In peacetime, one might wonder whether some of these subjects might not produce anxiety in an inexperienced mother. In wartime, with doctors growing scarcer, they may be unusually valuable on the family book-shelf.

MARY M. ALDRICH.

THE book, of 261 pages, entitled *Atlas of Ovarian Tumors*[3] by Dr. Gemma Barzilai, is beautifully done. The illustrations, many of which are in colors, are excellent. Many of them are taken from slides used by the author in teaching at the University of Padua. Material used in preparing the book was also obtained in Vienna, Istanbul, and Milan. Later

[1] THE ANTIGONADOTROPIC FACTOR; WITH CONSIDERATION OF THE ANTIHORMONE PROBLEM. By Bernhard Zondek and Felix Sulman. Baltimore: The Williams & Wilkins Co., 1942.

[2] HEALTHY BABIES ARE HAPPY BABIES; A COMPLETE HANDBOOK FOR MODERN MOTHERS. By Josephine Hemenway Kenyon, M.D. 3d rev. ed. Boston: Little, Brown & Co., 1943.

[3] ATLAS OF OVARIAN TUMORS. By Gemma Barzilai, M.D. With a preface by Fred W. Stewart, M.D. New York: Grune & Stratton, 1942.

work was done by the author at the Woman's Hospital in New York City.

In a work, the principal purpose of which is to present reproductions of microscopic preparations, the text is relatively brief. The legends found under the illustrations are sufficiently full to be adequately informative. The text is well done and conforms to the accepted ideas of gynecological pathology. The author is to be commended in having produced a valuable addition to present day literature of gynecological pathology.

The reviewer agrees with the statement of Dr. Stewart in the preface, "Dr. Barzilai has written a volume useful for pathologists and clinicians, one timely, modern, complete and excellently illustrated. It should be an essential part of every library even remotely concerned with the literature of gynecology." W. C. DANFORTH.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

A STUDY OF ENDOMETRIOSIS, ENDOSALPINGIOSIS, ENDOCERVICOSIS, AND PERITONEO-OVARIAN SCLEROSIS; A CLINICAL AND PATHOLOGIC STUDY. By James Robert Goodall, O.B.E., B.A., M.D., C.M., D.Sc., F.I.C.S. (Hon.), F.R.C.O.G. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1943.

FIRST AID; SURGICAL AND MEDICAL. By Warren H. Cole, M.D., F.A.C.S., and Lieutenant Colonel Charles B. Puestow. 2d ed. New York and London: D. Appleton-Century Co., 1943.

ESSENTIALS OF INDUSTRIAL HEALTH. By C. O. Sappington, M.D., Dr.P.H. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1943.

TRANSACTIONS OF THE AMERICAN GYNECOLOGICAL SOCIETY. Volume 67 for the Year 1942. Edited by Howard C. Taylor, Jr., M.D. St. Louis: The C. V. Mosby Co., 1943.

UROLOGY IN GENERAL PRACTICE. By Nelse F. Ockerblad, B.S., M.D., F.A.C.S., and Hjalmer E. Carlson, B.S., A.M., M.D., F.A.C.S. Chicago: The Year Book Publishers, Inc., 1943.

WAR INJURIES OF THE CHEST. Edited by H. Morriston Davies and Robert Coope. Edinburgh: E. & S. Livingstone, 1942.

GOUT. By John H. Talbott, M.D. Edited by Henry A. Christian, A.M., M.D., LL.D., Sc.D. (Hon.), F.A.C.P., Hon. F.R.C.P. (Can.). Reprinted from *Oxford Loose-Leaf Medicine* with the same page numbers as in that work. New York, London, and Toronto: Oxford University Press, 1943.

AVIATION MEDICINE. By Louis Hopewell Bauer, M.D. Edited by Henry A. Christian, A.M., M.D., LL.D., Sc.D. (Hon.), F.A.C.P., Hon. F.R.C.P. (Can.). Reprinted from *Oxford Loose-Leaf Medicine* with the same page numbers as in that work. New York, London, and Toronto: Oxford University Press, 1943.

OVARIAN TUMORS. By Samuel H. Geist, M.D. New York and London: Paul B. Hoeber, Inc., 1942.

A GUIDE TO PRACTICAL NUTRITION; A SERIES OF ARTICLES ON NUTRITION, SPONSORED BY THE COMMITTEE ON NUTRITION AND DEFICIENCY DISEASES OF THE PHILADELPHIA COUNTY MEDICAL SOCIETY. Edited for the Committee by Michael G. Wohl, M.D., and John H. Willard, M.D. Reprinted from Philadelphia Medicine, 1941-1942. Philadelphia: The Philadelphia County Medical Society, 1943.

FRACTURES AND FRACTURE TREATMENT IN PRACTICE. By Kurt Colsen, M.D. Johannesburg, Union of South Africa: Witwatersrand University Press, 1942.

SKIN GRAFTING OF BURNS; PRIMARY CARE, TREATMENT, REPAIR. By James Barrett Brown, M.D., and Frank McDowell, M.D. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1943.

ATLAS OF OBSTETRIC TECHNIC. By Paul Titus, M.D. St. Louis: The C. V. Mosby Co., 1943.